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Notices

of the American Mathematical Society

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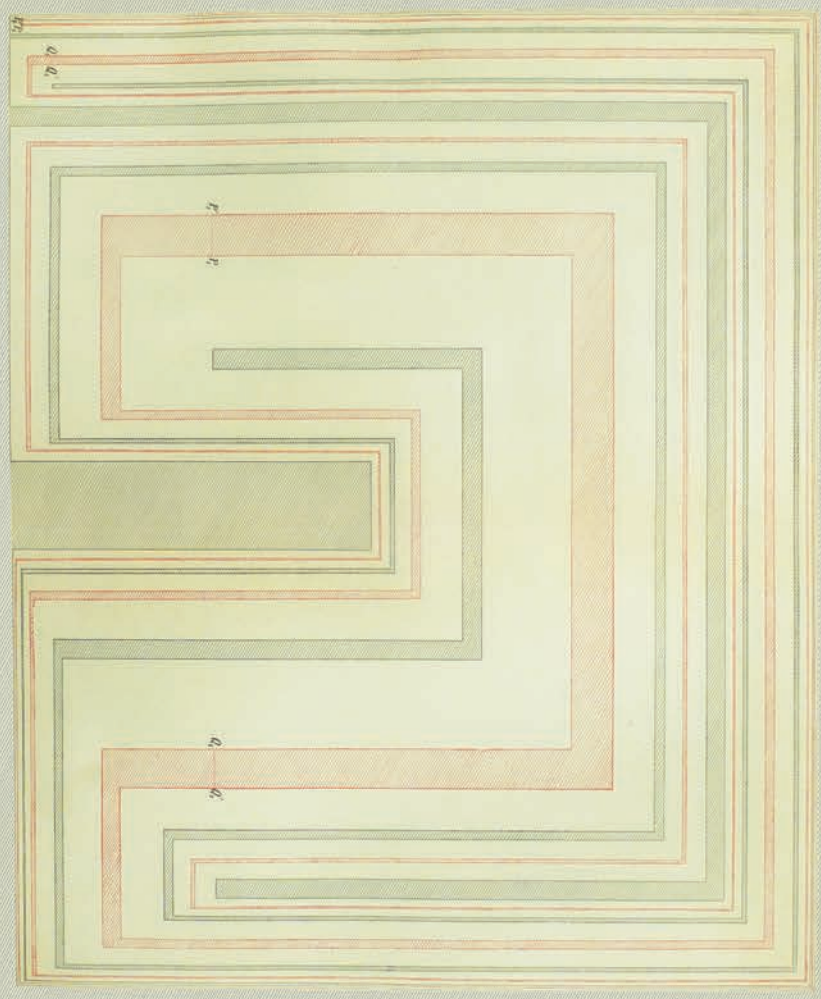

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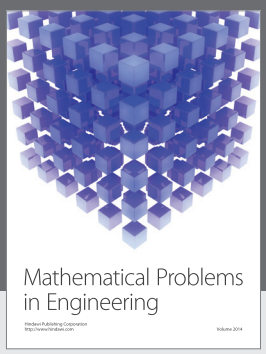
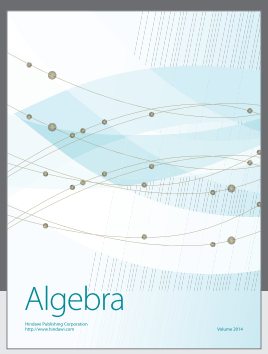
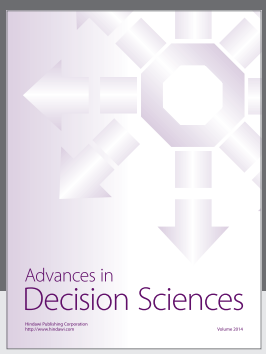
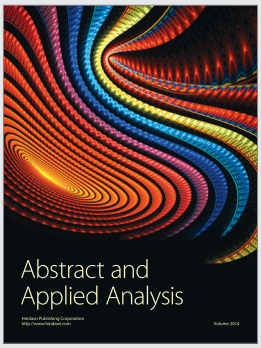
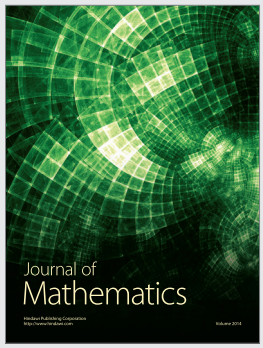
About the cover: From L. E. J. Brouwer's "Zur Analysis Situs"
(see page 610)











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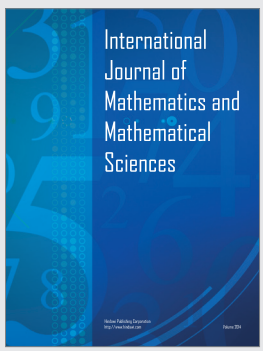

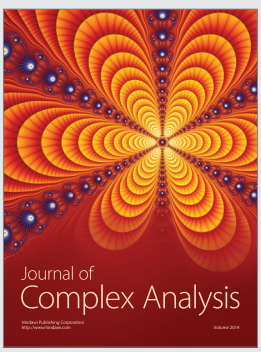

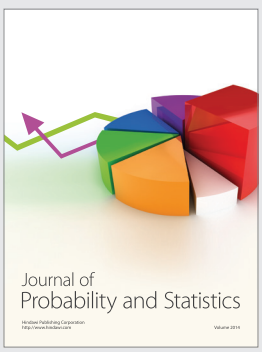

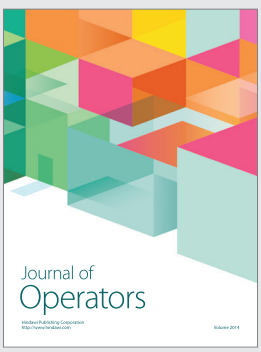

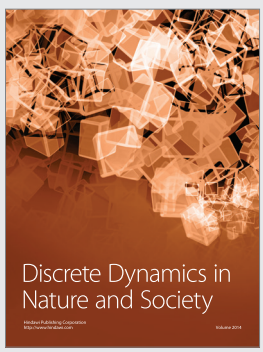

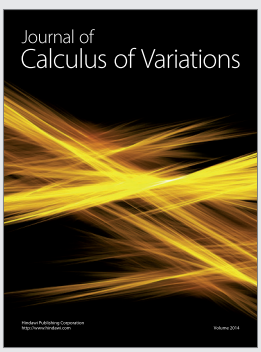

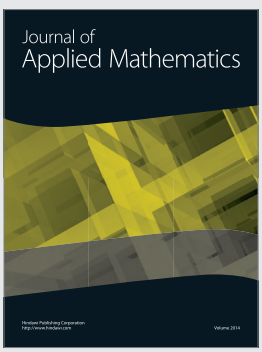

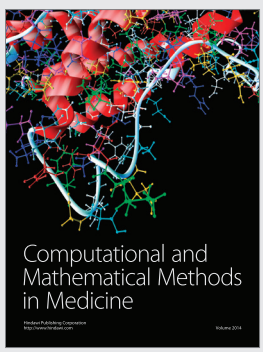

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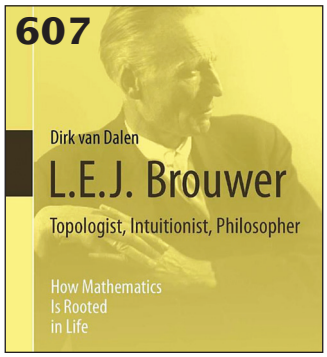
Notices

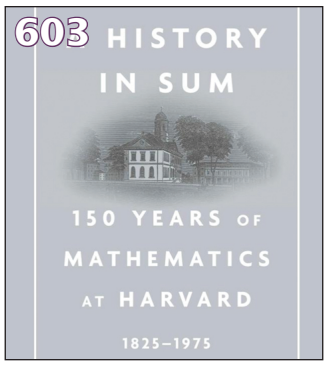
of the American Mathematical Society

June/July 2014

Communications

Commentary





It is already mid-year, and life at the *Notices* is as fascinating as ever. This month we showcase an article about moment inequalities for maxima of partial sums, some reminiscences about teaching, and a memorial article for the complex analyst Pierre Lelong. In addition, there is an important Communication about the International Mathematical Union—significant because of the upcoming meeting in Korea. We also include a timely and provocative article about recent surveillance activity by the National Security Agency. Pleasant reading.

—Steven G. Krantz, Editor

Features

Notices

of the American Mathematical Society

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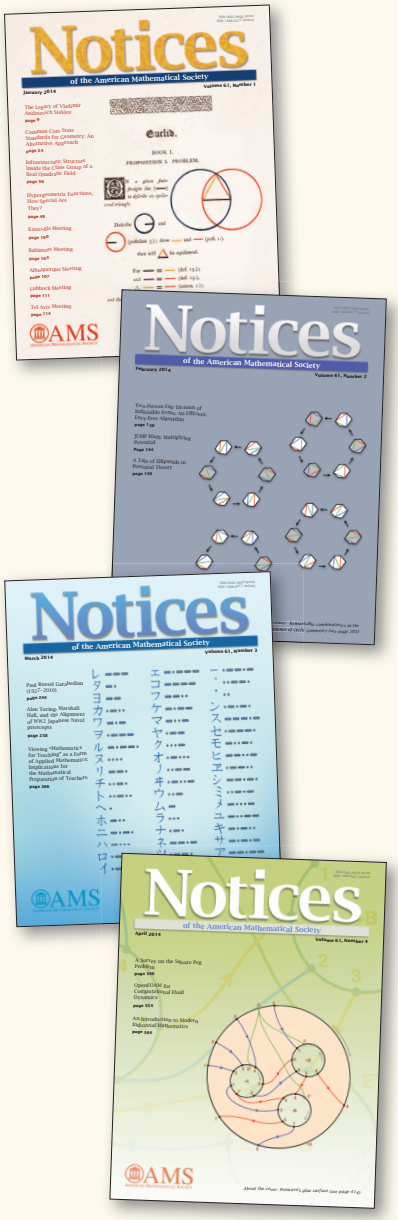
Call for Applications & Nominations

Chief Editor of the *Notices*



Applications and nominations are invited for the position of Editor of the *Notices of the American Mathematical Society*, to commence with the January 2016 issue. The Society seeks an individual with strong mathematical research experience, broad mathematical interests, and a commitment to communicating mathematics to a diverse audience at a wide range of levels. The applicant must demonstrate excellent written communication skills.

The Editor has editorial responsibility for a major portion of the *Notices* within broad guidelines. The goal of the *Notices* is to serve all mathematicians by providing a lively and informative magazine containing exposition about mathematics and mathematicians, and information about the profession and the Society.

The Editor is assisted by a board of Associate Editors, nominated by the Editor, who help to fashion the contents of the *Notices* and solicit material for publication. Some writing, and all publication support, will be provided by AMS staff in Providence. The Editor will operate from his or her home institution with part-time secretarial support. In order to begin working on the January 2016 issue, some editorial work would begin in early 2015.

Nominations and applications (including curriculum vitae) should be sent to the Executive Director, Donald E. McClure, at exdir@ams.org. Confidential inquiries may also be sent directly to the Executive Director or to any other member of the search committee (Dan Abramovich, Amber Puha, Carla Savage, or David Vogan).

To receive full consideration, nominations and applications should be sent on or before August 31, 2014.

Letters to the Editor

The Last(?) Word in Rigor

Regarding E. Galperin's letter in the March 2014 *Notices*: While the author makes a novel case for the left derivative, I feel compelled to add—in all seriousness—that the central difference limit lim $[f(x+dx/2)-f(x-dx/2)]/dx$ should be considered as a superior alternative to either the left or the right limits. It is symmetrical, immediately links the derivative to open sets, and also allows more natural derivations of many differential equations in mathematical physics. Altogether a more balanced definition.

—Niall Ryan
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(Received March 11, 2014)

"Mathematics for Teaching" as a Form of Applied Mathematics

Regarding "Viewing 'mathematics for teaching' as a form of applied mathematics: Implications for the mathematical preparation of teachers", by Andreas J. Stylianides and Gabriel J. Stylianides, *Notices*, March 2014: Since I did not attend seventh grade in the U.S., I had to resort to Wikipedia: "In the United States, [seventh grade] is important in mathematics, students focus commonly on an introduction to pre-algebra or the beginnings of algebra, including ratio, proportion, percent. New topics sometimes include scientific notation, concepts with negative numbers, and more advanced geometry." In other words, a laundry list of topics and not a whiff of what it means to make one's case for whatever one asserts.

As I recall it, already at that age, we were impressed with the fact that to "assert" was of no import whatsoever and the words most regularly used in the homework and in the exams were "Montrer" and "Demontrer", in English "Prove". None of us would have even thought of listing a number of cases and/or making a drawing to make our case. And I still have the textbook *Arithmétique et Géometrie, Classe de Cinquième*, by C. Lebossé and C. Hémery, to prove it.

In contradistinction, looking at a calculus text of which the market says that it has our overwhelming approval, I was not surprised not to find a single exercise in which the governing verb would be "Prove". Most of the time it is "Find".

The "classroom scenario that [the authors] use to exemplify elements of knowledge of MfT (Mathematics for Teaching) in the particular domain of proof" would thus seem to be completely of *our* own making and not call for research: if prospective teachers were impressed by educologists as I was as a child by my mathematics teachers, the above scenario could not occur.

—Alain Schremmer
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(Received March 3, 2014)

How to Make Maths Fun

In the Opinion column of the *Notices*, August 2013, J. A. Loera wishes "…to encourage all AMS members to become active in promoting mathematics to the public." The most significant and needy members of that public are parents and their school-age children.

However, to be successful, any promotion must first overcome a massive hurdle. Parents, and the public in general, must be stopped from announcing to children their negative experiences of fear and hatred of mathematics.

"Math was not my favorite subject," "Math is just for brainy people," "Math was a nightmare for me," "I hated math" are harmful statements, especially in homes. Parents do not realize that such statements infect their children to then acquire this fear and hatred of the subject, down the generations. In my experience, this is the root of the problem. Because of the style of presentation in infant school, small children enjoy problems involving mathematical processes. As soon as the subject acquires a title, "Math", and homework arrives on the dining room table, the parents' negative connotations surface. It is interesting that no other subject has such a universally bad press.

How can this be changed? Today the obvious vehicle for that is the Internet, in the style of *Sesame Street*, with a choice of best teachers and producers, video lessons to be incorporated into the curriculum of primary as well as secondary schools. These could run with the teacher's personal input, live as a presenter in the classroom, and by downloading to parents. That way, parents, children, and even negatively experienced teachers could be reeducated as to the fun available within mathematics. I see a significant role for mathematical societies throughout the world to sponsor and design such a curriculum.

—Joe Hammer
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(Received April 1, 2014)

Correction

The May 2014 issue carried the article "Happy 91st, Cathleen Synge Morawetz". The article incorrectly stated that Morawetz is the only woman mathematician to have received the National Medal of Science. In fact, Karen K. Uhlenbeck also received the National Medal of Science, in 2000, two years after Morawetz. We apologize for the error.

—Allyn Jackson

Moment Inequalities for Maxima of Partial Sums in Probability with Applications in the Theory of Orthogonal Series

Ferenc Móricz

Dedicated to the memory of Paul Erdős on the 100th anniversary of his birthday

Let $(X_k : k = 1, 2, \ldots)$ be a sequence of random variables. It is not assumed that these X_k's are mutually independent or that they are identically distributed. We set

$$S_{b,n} := \sum_{k=b+1}^{b+n} X_k \quad \text{and} \quad M_{b,n} := \max_{1 \le k \le n} |S_{b,k}|,$$

where $b \ge 0$ and $n \ge 1$ are integers. Thus, $M_{b,n}$ is the largest magnitude for the n consecutive partial sums formed from the n consecutive X_k's beginning with X_{b+1}. Furthermore, for each vector $X_{b,n} := (X_{b+1}, X_{b+2}, \ldots, X_{b+n})$ of n consecutive X_k's, let $F_{b,n}$ denote their joint distribution function.

The object of this paper is to provide bounds on $E(M_{b,n}^p)$ in terms of given bounds on $E|S_{b,n}|^p$, where $p > 1$ and E is the symbol for the expected value of random variables. We emphasize that it is not assumed that these X_k's are independent. The only restrictions on the dependence will be those imposed on the assumed bounds on $E|S_{b,n}|^p$. These assumed bounds are guaranteed under a suitable dependence restriction, for example, martingale differences, weak multiplicativity of finite order, orthonormality, etc.

Bounds on $E(M_{b,n}^p)$ are of use in deriving bounds on the tail distribution of the maximum of certain partial sums in order to study convergence properties of $S_n := S_{0,n}$ as $n \to \infty$. For development of such results under various dependence restrictions, the theorems of this paper reduce the problem of placing appropriate bounds on $E(M_{b,n}^p)$ to the easier problem of placing appropriate bounds on $E|S_{b,n}|^p$.

The problem posed above is treated essentially in a setting close to that of Serfling [26], whose results are contained as special cases in our Theorems 1 and 3 stated in the next two sections.

Ferenc Móricz is program director in analysis, Bolyai Institute, the University of Szeged, Hungary. His email address is moricz@math.u-szeged.hu.

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The Generalized Rademacher-Menshov Maximal Moment Inequality

In the following, the symbol $g(F_{b,n})$ denotes a nonnegative functional depending on the joint distribution function $F_{b,n}$ of the vector $X_{b,n}$, where $b \ge 0$ and $n \ge 1$ are integers. Throughout the paper, we will assume that $g(F_{b,n})$ possesses the following property of rather general nature:

$$g(F_{b,k}) + g(F_{b+k,\ell}) \le g(F_{b,k+\ell}) \tag{1}$$

for all integers $b \ge 0$ and $1 \le k < k + \ell$. It may be called the *superadditivity* property of $g(F_{b,n})$. In case "$\le$" is replaced by "$=$" in (1), we may say that $g(F_{b,n})$ possesses the commonly known *additivity* property. Examples are

$$g(F_{b,n}) := n^\alpha \quad \text{or} \quad g(F_{b,n}) := \sum_{k=b+1}^{b+n} a_k^2,$$

where $\alpha \ge 1$ or (a_k) is a sequence of real numbers. In most cases, $a_k^2 = \mathrm{Var}(X_k)$, is the finite variance of X_k, but this remark plays no role in the theorems stated in the sequel.

The next maximal moment inequality, indicated in the subtitle above, was proved by the present author [13, Theorem 3].

Theorem 1. *Suppose that there exists a functional $g(F_{b,n})$ satisfying condition* (1)*. If*

$$E|S_{b,n}|^p \le g(F_{b,n}) \tag{2}$$

for all $b \ge 0$ and $n \ge 1$, where $p > 1$, then we have

$$E(M_{b,n}^p) \le (\log 2n)^p g(F_{b,n}) \tag{3}$$

for all $b \ge 0$ and $n \ge 1$.

Here and in the sequel, by "log" we denote the logarithm to the base 2.

Proof. It goes by induction with respect to n. Since $M_{b,1} = |S_{b,1}|$, (3) is obvious for $n = 1$.

Now, we assume as the induction hypothesis that (3) holds for each integer b and for each integer less than n, where $n > 1$, and we will prove it for n itself. To this effect, we make use of the so-called *bisection* technique. To this effect, let m be the integer part of $(n + 2)/2$. It is easy to check that

$n = 2m-2$ or $2m-1$, while $n-m = m-2$ or $m-1$.

To sum up, in either case we have

$$2(m-1) \le n \quad \text{and} \quad n - m \le m - 1. \tag{4}$$

Let $b \ge 0$ be arbitrary. For $m \le k \le n$, we clearly have

$$|S_{b,k}| \le |S_{b,m}| + |S_{b+m,k-m}|,$$

whence for any such k it follows that

$$|S_{b,k}| \le |S_{b,m}| + M_{b+m,n-m}.$$

Since, for $1 \le k < m$, by definition we have

$$|S_{b,k}| \le M_{b,m-1};$$

thus, for any k between 1 and n, we may estimate

$$|S_{b,k}| \le |S_{b,m}| + (M_{b,m-1}^p + M_{b+m,k-m}^p)^{1/p},$$

that is, we have

$$M_{b,n} \le |S_{b,m}| + (M_{b,m-1}^p + M_{b+m,n-m}^p)^{1/p}.$$

Applying the Minkowski inequality gives

$$\begin{aligned}(E(M_{b,n}^p))^{1/p} &\le (E|S_{b,m}|^p)^{1/p} + (E(M_{b,m-1}^p) \\ &\quad + E(M_{b+m,n-m}^p))^{1/p}.\end{aligned} \tag{5}$$

By the induction hypothesis, conclusion (3) of the theorem holds for any integer less than n. Thus, by the choice of m, we have

$$[E(M_{b,m-1}^p)]^{1/p} \le (\log 2(m-1)) g^{1/p}(F_{b,m-1})$$

and

$$\begin{aligned}&[E(M_{b+m,n-m}^p)]^{1/p} \\ &\quad \le (\log 2(n-m)) g^{1/p}(F_{b+m,n-m}) \\ &\quad \le (\log 2(m-1)) g^{1/p}(F_{b+m,n-m}),\end{aligned}$$

where the last inequality is due to (4). Putting these two inequalities together, by (1) we find that

$$\begin{aligned}&E(M_{b,m-1}^p) + E(M_{b+m,n-m}^p) \\ &\quad \le (\log 2(m-1))^p (g(F_{b,m-1}) + g(F_{b+m,n-m})) \\ &\quad \le (\log 2(m-1))^p g(F_{b,n}).\end{aligned} \tag{6}$$

Here we also took into account that, due to (1), the functional $g(F_{b,k})$ is nondecreasing in k.

Finally, by (2), we have

$$E|S_{b,m}|^p \le g(F_{b,m}) \le g(F_{b,n}). \tag{7}$$

Combining inequalities (5)–(7) and taking (4) into account gives

$$\begin{aligned}&[E(M_{b,n}^p)]^{1/p} \\ &\quad \le (1 + \log 2(m-1)) g^{1/p}(F_{b,n}) \\ &\quad \le (1 + \log n) g^{1/p}(F_{b,n}) = (\log 2n) g^{1/p}(F_{b,n}).\end{aligned}$$

The inequality just obtained is equivalent to (3) which was to be proved. Thus it follows by induction that (3) holds true for all $b = 0, 1, 2, \ldots$ and $n = 1, 2, \ldots$. The proof of Theorem 1 is complete. □

We note that Theorem 1 is a special case of the following more general Theorem 2. Before formulating it, we introduce a recurrence definition. Let $\lambda(n)$ be a positive and nondecreasing function of the natural number n. We set

$$\begin{aligned}&\Lambda(1) := \lambda(1) \quad \text{and for } n \ge 2, \\ &\Lambda(n) := \lambda(m) + \Lambda(m-1),\end{aligned} \tag{8}$$

where m denotes the integer part of $(n + 2)/2$ as in the proof of Theorem 1 before. Now, the proving method of Theorem 1 can be repeated with minor changes in notation (see the details in [13, Theorem 4]) and yields the following.

Theorem 2. *Suppose that there exist a functional $g(F_{b,n})$ satisfying condition* (1) *and a positive and nondecreasing function $\lambda(n)$ such that*

$$E|S_{b,n}|^p \le \lambda^p(n) g(F_{b,n})$$

for all $b \ge 0$ and $n \ge 1$, where $p > 1$. Let $\Lambda(n)$ be defined in (8)*. Then we have*

$$E(M_{b,n}^p) \le \Lambda^p(n) g(F_{b,n})$$

for all $b \ge 0$ and $n \ge 1$.

Clearly, Theorem 1 is a special case of Theorem 2, where $\lambda(n)$ equals 1 for all n, due to the fact that

$$\Lambda(n) \le \log 2n.$$

Indeed, by (4) we have

$$1 + \log 2(m-1) \le \log 2n.$$

The subtitle "The Generalized Rademacher-Menshov Maximal Moment Inequality" of this section will be clear in the section "Pointwise Convergence of Orthogonal Series" below.

The Generalized Erdős-Stechkin Maximal Moment Inequality

We remind the reader that on the right-hand side of condition (2) in Theorem 1, the exponent of the functional $g(F_{b,n})$ equals 1. On the other hand, on the right-hand side of condition (9) in the next Theorem 3, the exponent r of the functional $g(F_{b,n})$ will be greater than 1.

The next maximal moment inequality indicated in the subtitle above was also proved by the present author [13, Theorem 1].

Theorem 3. *Suppose that there exists a functional $g(F_{b,n})$ satisfying condition* (1) *and*

$$E|S_{b,n}|^p \le g^r(F_{b,n}) \tag{9}$$

for all $b \ge 0$ and $n \ge 1$, where $p > 1$ and $r > 1$. Then we have

$$E(M_{b,n}^p) \le C g^r(F_{b,n}) \tag{10}$$

for all $b \ge 0$ and $n \ge 1$, provided that the constant C is large enough.

Although the specific value of C will have no importance for us, the constant C in (10) may be taken as

$$C = (1 - 2^{(1-r)/p})^{-p}. \tag{11}$$

Proof. We are to find a constant $C \ge 1$, depending only on p and r such that

$$E(M_{b,n}^p) \le C g^r(F_{b,n}) \tag{12}$$

for all $b \ge 0$ and $n \ge 1$. Analogous to the proof of Theorem 1, the proof of (12) will go by induction with respect to n. Since $M_{b,1} := |S_{b,1}|$ and $C \ge 1$, (12) is obvious for $n = 1$.

Now, we assume as induction hypothesis that (12) holds for each integer less than n, where $n > 1$, and we will prove it for n itself. We will make use of another variant of the so-called *bisection* technique. To this effect, let m be an integer such that $1 \le m \le n$ and

$$g(F_{b,m-1}) \le \frac{1}{2} g(F_{b,n}) < g(F_{b,m}), \tag{13}$$

with the agreement that $g(F_{b,m-1})$ on the left is taken to be zero if $m = 1$. Then (1) and (13) imply that

$$g(F_{b-m,n-m}) \le g(F_{b,n}) - g(F_{b,m}) < \frac{1}{2} g(F_{b,n}). \tag{14}$$

Now, for $m \le k \le n$, we clearly have

$$|S_{b,k}| \le |S_{b,m}| + |S_{b+m,k-m}| \le |S_{b,m}| + M_{b+m,k-m},$$

with the agreement that $M_{b+m,n-m}$ on the right is taken to be zero if $m = n$. For $1 \le k < m$, we clearly have

$$|S_{b,k}| \le M_{b,m-1},$$

and hence we get for all $1 \le k \le n$,

$$|S_{b,k}| \le |S_{b,m}| + (M_{b,m-1}^p + M_{b+m,k-m}^p)^{1/p}.$$

Thus, we conclude that

$$M_{b,n} \le |S_{b,m}| + (M_{b,m-1}^p + M_{b+m,n-m}^p)^{1/p},$$

and by the Minkowski inequality, we have

$$(E(M_{b,n}^p))^{1/p} \le (E|S_{b,m}|^p)^{1/p} + (E(M_{b,m-1}^p) + E(M_{b+m,n-m}^p))^{1/p}. \tag{15}$$

Since $m - 1 < n$, we may apply the induction hypothesis, and by (12) and (13) we conclude that

$$E(M_{b,m-1}^p) \le C g^r(F_{b,m-1}) \le \frac{C}{2^r} g^r(F_{b,n}). \tag{16}$$

If the indices in (10) are restricted to $b + m$ and $1 \le k \le n - m$, then only the random variables $X_{b,m+1}, \ldots, X_{b,n}$ are involved. Since $n - m < n$, the induction hypothesis applies again, and by (12) we obtain

$$E(M_{b+m,n-m}^p) \le C g^r(F_{b+m,n-m}) \le \frac{C}{2^r} g^r(F_{b,n}), \tag{17}$$

the last inequality following from (14). In case $m = n$, inequality (17) is trivial.

Finally, by (9) and the monotonicity of $g(F_{b,n})$ in n, we get

$$E|S_{b,m}|^p \le g^r(F_{b,m}) \le g^r(F_{b,n}). \tag{18}$$

Collecting the inequalities in (15)–(18) yields

$$(E(M_{b,n}^p))^{1/p} \le \Big(1 + \frac{C^{1/p}}{2^{(r-1)/p}}\Big) g^{r/p}(F_{b,n}).$$

Taking into account that $r > 1$, hence it follows that if C is large enough, then

$$(E(M_{b,n}^p))^{1/p} \le C^{1/p} g^{r/p}(F_{b,n}),$$

which is equivalent to (10) to be proved. The smallest C satisfying the inequality

$$1 + \frac{C^{1/p}}{2^{(r-1)/p}} \le C^{1/p}$$

is given in (11). This completes the proof of Theorem 3. □

The subtitle "The Generalized Erdős-Stechkin Maximal Moment Inequality" of this section will be explained in the section "Pointwise Convergence of Fourier Series" below.

Pointwise Convergence of Orthogonal Series

Instead of random variables, one may also consider real-valued functions $(f_k(t) : k = 1, 2, \ldots)$ over some bounded interval $I := [a_1, a_2]$. We assume that these functions $f_k(t)$ are integrable in the Lebesgue sense. To investigate pointwise convergence of the infinite series $\sum_{k=1}^{\infty} f_k(t)$, we introduce such notation that is analogous to that introduced in the preceding sections. Namely, this time we set

$$S_{b,n}(t) := \sum_{k=b+1}^{b+n} f_k(t) \quad \text{and} \quad M_{b,n}(t) := \max_{1 \le k \le n} |S_{b,k}(t)|, \tag{19}$$

where $b \geq 0$ and $n \geq 1$ are integers. In statements about $S_{0,n}(t)$ only, the abbreviated notation $S_n(t)$ will be used.

Furthermore, we denote by $g(b,n)$ a nonnegative functional depending only on the functions $f_{b+1}(t), f_{b+2}(t), \ldots, f_{b+n}(t)$, which possesses the subadditivity property (cf. (1))

$$g(b,k) + g(b+k,\ell) \leq g(b,k+\ell) \tag{20}$$

for all $b \geq 0$ and $1 \leq k < k+\ell$.

The analogue of Theorem 1 reads as follows.

Theorem 4. *Suppose that there exists a functional $g(b,n)$ satisfying condition* (20) *and*

$$\int_I |S_{b,n}(t)|^p dt \leq g(b,n)$$

for all $b \geq 0$ and $n \geq 1$, where $p > 1$. Then we have

$$\int_I M_{b,n}^p(t)dt \leq (\log 2n)^p g(b,n)$$

for all $b \geq 0$ and $n \geq 1$.

The proof of Theorem 4 runs along the same lines as that of Theorem 1.

Next, we consider the special case, where

$$f_k(t) := a_k \varphi_k(t), \quad k = 1, 2, \ldots,$$

whith (a_k) a sequence of real numbers (the so-called coefficients), while $(\varphi_k(t))$ is an orthonormal system (in abbreviation: ONS) on the interval I; that is, the functions $\varphi_k(t)$ are square integrable on I and

$$\int_I \varphi_k(t)\varphi_\ell(t)dt = \begin{cases} 0 & \text{if} \quad k \neq \ell, \\ 1 & \text{if} \quad k = \ell; \ k, \ell = 1, 2, \ldots. \end{cases}$$

By orthonormality, we clearly have (cf. notation in (19))

(21)

$$\int_I S_{b,n}^2(t)dt := \int_I \Big(\sum_{k=b+1}^{b+n} a_k \varphi_k(t) \Big)^2 dt$$
$$= \sum_{k=b+1}^{b+n} \sum_{\ell=b+1}^{b+n} a_k a_\ell \int_I \varphi_k(t)\varphi_\ell(t)dt = \sum_{k=b+1}^{b+n} a_k^2.$$

This means that by choosing $p := 2$ and

$$g(b,n) := \sum_{k=b+1}^{b+n} a_k^2, \quad b \geq 0 \quad \text{and} \quad n \geq 1,$$

condition (20) is trivially satisfied, even with the sign "=" in place of "≤" (the so-called additive case).

The best-known example of an orthogonal system of functions is the *trigonometric system*:

$$1. \cos t, \ \sin t, \ \cos 2t, \ \sin 2t, \ \ldots, \ \cos kt, \ \sin kt, \ldots$$

on the interval $I := [0, 2\pi]$. Taking into account the periodicity of these functions, they are orthogonal on any interval of length 2π. The orthogonality is immediately clear if we apply the trigonometric identities

$$\cos\alpha\cos\beta = \frac{1}{2}(\cos(\alpha+\beta) + \cos(\alpha-\beta)), \tag{22}$$
$$\sin\alpha\cos\beta = \frac{1}{2}(\sin(\alpha+\beta) + \sin(\alpha-\beta)),$$
$$\sin\alpha\sin\beta = \frac{1}{2}(\cos(\alpha-\beta) - \cos(\alpha+\beta)). \tag{23}$$

However, the trigonometric system is not a normal one, since

$$\int_0^{2\pi} 1dt = 2\pi, \int_0^{2\pi} \cos^2 ktdt$$
$$= \int_0^{2\pi} \sin^2 ktdt = \pi, \qquad k = 1, 2, \ldots.$$

Thus, the orthonormal trigonometric system is the following one:

$$\frac{1}{\sqrt{2\pi}}, \quad \frac{\cos kt}{\sqrt{\pi}}, \quad \frac{\sin kt}{\sqrt{\pi}}, \quad k = 1, 2, \ldots.$$

The fundamental result in the theory of orthogonal series is the *Rademacher-Menshov inequality* (see [10], [24], and also [1, p. 80]). The following Corollary 5 is a special case of Theorem 4, where $p = 2$ and $g(b,n)$ is given in (21).

Corollary 5. *If $(\varphi_k(t))$ is an arbitrary ONS on a bounded interval I and (a_k) is a sequence of real numbers, then we have*

$$\int_I M_{b,n}^2(t)dt \leq (\log 2n)^2 \sum_{k=b+1}^{b+n} a_k^2$$

for all $b \geq 0$ and $n \geq 1$, where $M_{b,n}(t)$ is defined in (19).

We recall that the next *Rademacher-Menshov theorem* on the pointwise convergence of the orthogonal series $\sum_{k=1}^{\infty} a_k \varphi_k(t)$ (see [10], [24] and also [1, Theorem 2.4.2, p. 88]) is proved by means of Corollary 5.

Theorem 6. *If $(\varphi_k(t))$ is an arbitrary ONS on a bounded interval I and (a_k) is a sequence of real numbers satisfying the condition*

$$\sum_{k=1}^{\infty} a_k^2 (\log k)^2 < \infty, \tag{24}$$

then the orthogonal series

$$\sum_{k=1}^{\infty} a_k \varphi_k(t) \tag{25}$$

converges almost everywhere (a.e.) on I.

Proof. We begin with proving that condition (24) implies the a.e. convergence of the subsequence

$(S_{2^n}(t))$. Indeed, on account of the orthonormality and conditions (21) and (24), we have

$$\sum_{n=1}^{\infty}\int_I n^2 S_{2^n,2^n}^2(t)\,dt = \sum_{n=1}^{\infty} n^2 \sum_{k=2^n+1}^{2^{n+1}} a_k^2 \le \sum_{n=1}^{\infty}\sum_{k=2^n+1}^{2^{n+1}} a_k^2(\log k)^2 < \infty.$$

By the monotone convergence theorem (called Beppo Levi's theorem in [25, pp. 35–36]), it follows that the series in the integrands above converges a.e.; that is, we have

$$\sum_{n=1}^{\infty} n^2 S_{2^n,2^n}^2(t) < \infty \quad \text{a.e.}$$

Next, we apply the familiar Cauchy inequality for sequences to obtain for $\nu \ge 2$ and $q \ge 1$ that

$$(S_{2^{\nu+q}}(t) - S_{2^\nu}(t))^2 = \Big(\sum_{n=\nu}^{\nu+q-1} S_{2^n,2^n}(t)\Big)^2 \le \sum_{n=\nu}^{\nu+q-1} n^2 S_{2^n,2^n}^2(t) \sum_{n=\nu}^{\nu+q+1}\frac{1}{n^2} = o\Big(\frac{1}{\nu}\Big) \to 0 \qquad \text{a.e. as } \nu \to \infty.$$

Therefore, the a.e. convergence of the subsequence $(S_{2^\nu}(t))$ is proved.

It remains to prove that the relation

(26)
$$M_{2^n,2^n}(t) := \max_{2^n<\nu\le 2^{n+1}} |S_\nu(t) - S_{2^n}(t)| \to 0 \text{ as } \nu \to \infty$$

also holds a.e. By Corollary 5 and condition (24) we estimate as follows:

$$\sum_{n=3}^{\infty}\int_I M_{2^n,2^n}^2(t)\,dt \le \sum_{n=3}^{\infty}(n+1)^2 \sum_{k=2^n+1}^{2^{n+1}} a_k^2 \le \sum_{n=3}^{\infty}\sum_{k=2^n+1}^{2^{n+1}} a_k^2(\log k)^2 = 2\sum_{k=9}^{\infty} a_k^2(\log k)^2 < \infty,$$

since $(n+1)^2 \le 2n^2$ if $n \ge 3$. Again, by the monotone convergence theorem, the series

$$\sum_{n=3}^{\infty} M_{2^n,2^n}^2(t)$$

converges a.e., whence (26) follows. This completes the proof of Theorem 6. □

A leading expert of the Hungarian orthogonal school, Károly Tandori [29] proved (see in Theorem 8 below) that in certain cases condition (24) is not only a sufficient, but also a necessary, condition for the a.e. convergence of an arbitrary orthogonal series (25).

Theorem 7. *If a sequence (a_k) of real numbers is such that*

$$|a_1| \ge |a_2| \ge \cdots \ge |a_k| \ge \cdots$$

and

$$\sum_{k=1}^{\infty} a_k^2(\log k)^2 = \infty,$$

then on any bounded interval I one can construct an ONS $(\varphi_k(t))$ so that the orthogonal series (25) diverges at each point of I.

We note that analogous theorems have been proved in the case of orthogonal random variables. As an example, we present the following.

Theorem 8. *Let $(X_k : k \ge 1)$ be a sequence of orthogonal random variables with finite second moments; that is,*

$$E(X_kX_\ell) = 0 \quad \text{and} \quad \sigma_k^2 := E(X_k^2) < \infty \quad \text{for } k \ne \ell;\ k,\ell = 1,2,\ldots.$$

If

$$\sum_{k=1}^{\infty}\frac{\sigma_k^2}{k^2}(\log k)^2 < \infty,$$

then the strong law of large numbers holds true:

$$\lim_{n\to\infty}\frac{1}{n}\sum_{k=1}^{n} X_k = 0 \quad \textit{almost surely}.$$

The proof of Theorem 8 hinges on Theorem 1 in the case $p = 2$ and on the next lemma (see, e.g., [1, Theorem 2.2.2, p. 72]).

Kronecker lemma. *Suppose the sequence $(\lambda_k : k \ge 1)$ of positive numbers is nondecreasing and tends to ∞ as $k \to \infty$. If a sequence (a_k) of real numbers is such that the series*

$$\sum_{k=1}^{\infty}\frac{a_k}{\lambda_k}$$

converges, then

$$\lim_{n\to\infty}\frac{1}{\lambda_n}\sum_{k=1}^{n} a_k = 0.$$

Further strong convergence as well as complete convergence theorems were proved in [13, pp. 308–313].

Pointwise Convergence of Fourier Series

We consider the trigonometric series

(27)
$$\sum_{k=1}^{\infty}(a_k\cos m_kt + b_k\sin m_kt),$$

where (a_k) and (b_k) are sequences of real numbers and (m_k) is a strictly increasing sequence of natural numbers. We recall that the series (27) is said to be *lacunary* (see, e.g., [30, p. 202]) if the inequality

(28)
$$\frac{m_{k+1}}{m_k} \ge \lambda > 1$$

is satisfied for all k.

Theorem 9 (Kolmogorov [7])**.** *If*

$$\sum_{k=1}^{\infty}(a_k^2+b_k^2)<\infty, \tag{29}$$

then the lacunary series (27) converges a.e.

We note that, by condition (29), the series (27) is the Fourier series of a square integrable function (see [25, p. 70] or [30, (1.1) Theorem, p. 127]).

We recall that a sequence (m_k) of natural numbers is said to satisfy *condition* (B_2) (see [2, p. 233]) if every natural number m can be represented only by a limited number of means in the form

$$m=m_k+m_\ell \quad \text{or} \quad m=m_k-m_\ell,$$

where m_k and m_ℓ are terms of the given sequence $(m_k : k=1,2,\dots)$.

Theorem 10 (Erdős [4], see also [2, p. 233])**.** *If a sequence (m_k) of natural numbers satisfies condition (B_2) and the sequences (a_k) and (b_k) of real numbers satisfy condition* (29)*, then the series* (27) *converges a.e.*

In the next section, we will prove that from the lacunary condition (28) it follows that (m_k) satisfies condition (B_2), while the converse implication is not true in general. Thus, Erdős's theorem is an essential generalization of Kolmogorov's theorem.

In his proof, Erdős made use of the following lemma of Sidon [28] (see also [2, p. 258]).

Lemma 11. *If a sequence (m_k) of natural numbers satisfies condition (B_2), then for any trigonometric polynomials*

$$T_n(t):=\sum_{k=1}^{n}a_k\cos m_kt \quad \text{or} \quad T_n(t):=\sum_{k=1}^{n}a_k\sin m_kt,$$

the following inequality holds true:

$$\int_0^{2\pi}T_n^4(t)dt\le C\Big(\int_0^{2\pi}T_n^2(t)dt\Big)^2=C\Big(\pi\sum_{k=1}^{n}a_k^2\Big)^2, \tag{30}$$

where the constant C is independent of the order n of the polynomial $T_n(t)$ and its coefficients (a_k).

Clearly, inequality (30) is a particular case of inequality (9), where $p=4$ and $r=2$,

$$S_{b,n}(t):=\sum_{k=b+1}^{b+n}a_k\cos m_kt \quad \text{or} \quad \sum_{k=b+1}^{b+n}a_k\sin m_kt,$$

and

$$g(b,n):=\sqrt{C}\pi\sum_{k=b+1}^{b+n}a_k^2.$$

Analyzing Erdős's proof in [4] (see also [2, pp. 259–263]) gave rise to the next so-called *Erdős-Stechkin maximal moment inequality.*

Theorem 12. *Suppose $p>2$ and there exists a sequence (a_k) of real numbers such that*

$$\int_I|S_{b,n}(t)|^pdt\le C\Big(\sum_{k=b+1}^{b+n}a_k^2\Big)^{p/2},$$

where C is a constant. Then we also have

$$\int_I\Big(\max_{1\le k\le n}|S_{b,k}(t)|\Big)^pdt\le C_\varepsilon C\Big(\sum_{k=b+1}^{b+n}a_k^2\Big)^{p/2},$$

where the constant C_ε does not depend on b,n, the sequence (a_k), and the exponent p for $p\ge 2+\varepsilon$, $\varepsilon>0$.

One can easily see that Theorem 12 was actually proved by Erdős [4] in the special case of such trigonometric polynomials, where the indices of the nonzero coefficients satisfy condition (B_2) and $p=4$. The general form as stated in Theorem 12 is proved along the analogous lines of Erdős's proof. The extension of Erdős's Theorem 10 was suggested by Stechkin, whose oral communication was later elaborated by Gaposhkin [6, pp. 29–31].

Proof of Sidon's Lemma. For the reader's convenience, we present the proof of Lemma 11 in the case of the cosine polynomial $T_n(t)$. Since

$$\begin{aligned}T_n^2(t)&:=\Big(\sum_{k=1}^{n}a_k\cos m_kt\Big)^2\\&=\sum_{k=1}^{n}a_k^2\cos^2m_k+\sum_{1\le k\ne\ell\le n}\sum a_ka_\ell\cos m_kt\cos m_\ell t,\end{aligned}$$

applying (22) and its particular case

$$\cos^2\alpha=\frac{1-\cos 2\alpha}{2}$$

gives that

$$\begin{aligned}T_n^4(t)&=\frac12\sum_{k=1}^{n}a_k^2+\frac12\sum_{k=1}^{n}a_k^2\cos 2m_kt\\&\quad+\frac12\sum_{1\le k\ne\ell\le n}\sum a_ka_\ell\cos(m_k+m_\ell)t\\&\quad+\frac12\sum_{1\le k\ne\ell\le n}\sum a_ka_\ell\cos(m_k-m_\ell)t\\&=:\sum_{j=0}^{2m_n}\mathcal{A}_j\cos jt\end{aligned} \tag{31}$$

with the coefficients

$$\mathcal{A}_0:=\frac12\sum_{k=1}^{n}a_k^2,$$

$$\mathcal{A}_j:=\frac12\sum_{1\le k\ne\ell\le n}a_ka_\ell,\qquad j=1,2,\dots,2m_n,$$

where the double summation is extended to those pairs (k,ℓ) for which

$$|m_k\pm m_\ell|=j \quad \text{and} \quad k\ne\ell.$$

It is obvious that

$$\mathcal{A}_0^2 = \frac{1}{4}\Big(\sum_{k=1}^{n} a_k^2 + \sum\sum_{1\le k\ne \ell\le n} a_k^2 a_\ell^2\Big). \tag{32}$$

Due to condition (B_2), the representation $|m_k \pm m_\ell| = j$ can hold only in finitely many cases, which we denote by s. This natural number s depends upon neither j nor n. Applying the familiar Cauchy inequality for sequences gives

$$\mathcal{A}_j^2 = \frac{1}{4}\Big(\sum\sum_{\substack{1\le k\ne \ell\le n\\ |m_k\pm m_\ell|=j}} a_k a_\ell\Big)^2 \le \frac{s}{4}\sum\sum_{1\le k\ne\ell\le n} a_k^2 a_\ell^2.$$

Hence it follows immediately that

$$\sum_{j=1}^{2m_n} \mathcal{A}_j^2 \le \frac{s}{4}\sum_{k=1}^{n} a_k^2 \sum_{\ell=1}^{n} a_\ell^2 \le \frac{s}{4}\Big(\sum_{k=1}^{n} a_k^2\Big)^2. \tag{33}$$

Combining (31)–(33) yields (30) as follows:

$$\begin{aligned}\int_0^{2\pi} T_n^4(t)\,dt &= \int_0^{2\pi}\Big(\sum_{j=0}^{2m_n}\mathcal{A}_j\cos jt\Big)^2 dt\\ &= \pi\Big(2\mathcal{A}_0^2 + \sum_{j=0}^{2m_n}\mathcal{A}_j^2\Big) \le \frac{\pi}{2}\Big(\sum_{k=1}^{n} a_k^2\Big)^2 + \frac{s\pi}{4}\Big(\sum_{k=1}^{n} a_k^2\Big)^2\\ &= \frac{\pi}{4}(2+s)\Big(\sum_{k=1}^{n} a_k^2\Big)^2 \le C\Big(\pi\sum_{k=1}^{n} a_k^2\Big)^2,\end{aligned}$$

$$\text{where } C := \frac{2+s}{4\pi}.$$

In the case of sine polynomials $T_n(t)$, the proof goes along the same lines as above, except that this time (23) is used instead of (22). The proof of Sidon's Lemma 11 is complete. □

Next, we will prove the assertion mentioned above that if a sequence $(m_k : k \ge 1)$ of natural numbers is lacunary, that is, for some $\lambda > 1$,

$$\frac{m_{k+1}}{m_k} \ge \lambda, \quad k = 1, 2, \ldots, \tag{34}$$

then a natural number s depending only on λ can be given such that for any natural number m, the representations

$$m = m_\ell + m_k \quad \text{and} \quad m = m_\ell - m_k, \quad \ell > k \ge 1,$$

can hold true for at most s pairs (l, k).

First, we justify this statement in the case where $m = m_\ell + m_k$, $\ell > k \ge 1$. It follows from (34) that

$$\frac{m_\ell}{m_{\ell-1}} \ge \lambda, \text{ and consequently, } m_k \le m_{\ell-1} \le \frac{1}{\lambda} m_\ell;$$

whence we conclude that

$$\begin{aligned} m_\ell < m = m_\ell + m_k &\le m_\ell + m_{\ell-1}\\ &\le m_\ell\Big(1 + \frac{1}{\lambda}\Big) = \frac{\lambda+1}{\lambda} m_k.\end{aligned}$$

Consequently, any number that can be written in the form $m = m_\ell + m_k$ satisfies the inequality

$$\frac{\lambda}{\lambda+1} m \le m_\ell < m. \tag{35}$$

Second, we consider the case where $m = m_\ell - m_k$, $\ell > k \ge 1$. Again, it follows from (34) that

$$\frac{m_{\ell-1}}{m_\ell} \le \frac{1}{\lambda}, \quad \text{and consequently,} \quad m_{\ell-1} \le \frac{1}{\lambda} m_\ell;$$

whence we can conclude that

$$m_\ell > m = m_\ell - m_k \ge m_{\ell-1} \ge m_\ell - \frac{1}{\lambda} m_\ell = \frac{\lambda-1}{\lambda} m_\ell.$$

Consequently, any number that can be written in the form $m = m_\ell - m_k$ satisfies the inequality

$$\frac{\lambda}{\lambda-1} m \ge m_\ell > m. \tag{36}$$

Given an integer m, denote by ℓ_1 the smallest integer and by ℓ_s the largest integer of those indices ℓ that occur in the representations $m = m_\ell \pm m_k$, where $\ell > k \ge 1$. It follows from (35) and (36) that

$$m_{\ell_1} \ge \frac{\lambda}{\lambda+1} m \quad \text{and} \quad m_{\ell_s} \le \frac{\lambda}{\lambda-1} m,$$

whence it follows that

$$\frac{m_{\ell_s}}{m_{\ell_1}} \le \frac{\lambda}{\lambda-1} \Big/ \frac{\lambda}{\lambda+1} = \frac{\lambda+1}{\lambda-1}.$$

On the other hand, it follows from (34) that

$$\frac{m_{\ell_s}}{m_{\ell_1}} = \frac{m_{\ell_s}}{m_{\ell_{s-1}}} \cdot \frac{m_{\ell_{s-1}}}{m_{\ell_{s-2}}} \cdots \frac{m_{\ell_1+1}}{m_{\ell_1}} \ge \lambda^s.$$

Combining the last two inequalities results in the inequality

$$\lambda^s \le \frac{m_{\ell_s}}{m_{\ell_1}} \le \frac{\lambda+1}{\lambda-1}. \tag{37}$$

Since $\lambda > 1$, we have

$$\lim_{s\to\infty} \lambda^s = \infty, \tag{38}$$

and this means that s must be bounded in (37).

To sum up, the representation $m = |m_\ell \pm m_k|$, where $\ell > k \ge 1$, can occur only in those cases where the index ℓ of m_ℓ equals in turn $\ell_1, \ell_2, \ldots, \ell_s$. This completes the proof of our assertion made just after (34).

To see that Erdős's Theorem 10 is an essential generalization of Kolmogorov's Theorem 9, we note that it is possible to construct such a sequence $(m_k : k \ge 1)$ of natural numbers that satisfies condition (B_2) and

$$\frac{m_\ell}{\ell^3} \le C, \quad \ell = 1, 2, \ldots, \tag{39}$$

where C is a constant (see, e.g., [2, p. 263]. This sequence (m_k) cannot be lacunary, since otherwise one gets a contradiction. Indeed, suppose the existence of some $\lambda > 1$ such that (34) holds true. Then we would have

$$m_{\ell+1} \ge \lambda m_\ell \ge \lambda^2 m_{\ell-1} \ge \cdots \ge \lambda^\ell m_1, \quad \ell = 1, 2, \ldots.$$

Taking into account (39), we would conclude hence that

$$1 = \frac{m_{\ell+1}}{m_{\ell+1}} \ge \frac{\lambda^\ell m_1}{C(\ell+1)^3}, \quad \ell = 1, 2, \ldots.$$

But this is a contradiction, since for any $\lambda > 1$, we have

$$\lim_{\ell\to\infty} \frac{\lambda^\ell}{(\ell+1)^3} = \infty.$$

This completes the proof of our remark made just before (39).

The Upper Part of the Law of the Iterated Logarithm

Let $(\varphi_k(t) : k = 1, 2, \ldots)$ be a system of real-valued functions that are measurable in the Lebesgue sense on the unit interval $[0, 1]$. The following definition was introduced by Alexits [1, pp. 87–88].

The system $(\varphi_k(t))$ is said to be an *equinormed, strongly multiplicative system* (ESMS) if

$$\int_0^1 \varphi_k(t)dt = 0, \quad \int_0^1 \varphi_k^2(t)dt = 1$$

for all $k = 1, 2, \ldots$, and

$$\int_0^1 \varphi_{k_1}^{\alpha_1}(t)\varphi_{k_2}^{\alpha_2}(t)\cdots\varphi_{k_\ell}^{\alpha_\ell}(t)dt = \int_0^1 \varphi_{k_1}^{\alpha_1}(t)dt \int_0^1 \varphi_{k_2}^{\alpha_2}(t)dt \cdots \int_0^1 \varphi_{k_\ell}^{\alpha_\ell}(t)dt$$

for all $1 \le k_1 < k_2 < \cdots < k_\ell$, each of the exponents $\alpha_1, \alpha_2, \ldots, \alpha_\ell$ may equal 1 or 2, and $\ell = 2, 3, \ldots$.

We note (see, e.g., [9]) that any system of stochastically independent functions on the unit interval [0,1] with mean value 0 and variance 1 is an ESMS. Another example is a *strongly lacunary* system of the trigonometric functions of the form (cf. (28))

$$\sqrt{2}\sin 2\pi m_k t, \quad \text{where} \quad \frac{m_{k+1}}{m_k} \ge 3, \quad k = 1, 2, \ldots.$$

We note that Alexits proved (see [1, Theorem 3.2.4, p. 189 and Theorem 3.2.7, p. 194]) that the *zero-one law* holds for an ESMS; that is, the series

$$\sum_{k=1}^\infty a_k\varphi_k(t) \text{ converges a.e. if } \sum_{k=1}^\infty a_k^2 < \infty,$$

$$\text{and diverges a.e. if } \sum_{k=1}^\infty a_k^2 = \infty.$$

Clearly, the functions of an ESMS can be considered as random variables on the unit interval [0,1] endowed with the Lebesgue measure. Given a sequence (a_k) of real numbers and an ESMS $(\varphi_k(t))$, we set

$$S_n(t) := \sum_{k=1}^n a_k\varphi_k(t)$$

$$\text{and } A_n := \left(\sum_{k=1}^n a_k^2\right)^{1/2}, \quad n = 1, 2, \ldots.$$

By the Erdős-Stechkin maximal moment inequality, we have for any $p > 2$,

(40)

$$\int_0^1 (\max_{1\le n\le N} |S_n(t)|)^p dt \le C_p A_N^p, \quad N = 1, 2, \ldots,$$

where the constant C_p does not depend on the sequence (a_k) and the system $(\varphi_k(t))$.

Now, repeating our proof of [12, Theorem 5] while making use of the maximal moment inequality (40), one can conclude the upper part of the law of the iterated logarithm (LIL) for any uniformly bounded ESMS, as stated in our next

Theorem 13. *Let $(\varphi_k(t))$ be a uniformly bounded* ESMS. *If*

$$A_n \to \infty \quad \textit{and} \quad \max_{1\le k\le n} |a_k| = o\Big(\sqrt{\frac{A_n^2}{\ln\ln A_n^2}}\Big),$$

*where by "*ln*" we denote the logarithm to the natural base e, then*

(41)

$$\text{meas}(\{t \in [0,1] : \limsup_{n\to\infty} \frac{S_n(t)}{\sqrt{2A_n^2\ln\ln A_n^2}} \le 1\}) = 1,$$

*where by "*meas*" we mean the Lebesgue measure on the real line.*

Indeed, taking into account [12, Remark 3, p. 119], the proof of [12, Theorem 5, pp. 130–132] supplemented by the maximal moment inequality (40) completes the proof of Theorem 13.

We note that only a weaker form of the upper part of the LIL was proved in [12, Theorem 5] for a uniformly bounded ESMS, owing to the unfortunate fact that the present author was unaware of the Erdős-Stechkin maximal moment inequality at that time.

We also note that it was Kolmogorov [8], who proved even the full part of the LIL (that is, (41) with "probability P" instead of "meas" and with "=1" in place of "≤ 1") for any sequence of uniformly bounded, stochastically independent random variables over a probability space $(\Omega, \mathcal{F}, P)$.

Historical Remarks

As we emphasized in the section "Pointwise Convergence of Fourier Series", the ingenious proof of Theorem 10 by Paul Erdős in 1943 exhibited the basic ideas that were applied by a number of mathematicians in proving maximal moment inequalities so far.

The superadditivity condition (1) is due to Serfling [26] in 1970. Our Theorems 1 and 3, proved in [13, Theorems 1 and 3], differ from those in [26, Theorems A and B] in the exponents on the right-hand sides in assumptions (2) and (9), and accordingly in conclusions (3) and (10), respectively. Furthermore, our proofs in [13] are more straightforward than the proofs in [26].

Assuming additivity instead of superadditivity, analogous inequalities were proved by Billingsley in his book [3, Theorem 12.2, p. 94, and Problem 5, p. 102], which appeared in 1968. We note that Billingsley also proved maximal inequalities, where the assumptions were not on the moments of sums $S_{b,n}$, but on product moments or joint tails of two nonoverlapping sums $S_{b,n}$ and $S_{a,m}$. The latter inequalities can be applied in such cases where the moments do not exist. It should also be noted that Billingsley's proofs work, with trivial changes, in the superadditive case as well.

We mention that Billingsley's theorems in [3, see Theorem 12.1 on p. 89, Theorem 12.2 on p. 94, Theorem 12.5 on p. 98, and Theorem 12.6 on p. 101] were generalized in our paper [21, see Theorems 1 and 2, and Corollaries 1 and 2, respectively] in 1982.

In a joint paper [20] with Serfling and Stout, we introduced a new notion called Q-superadditivity as follows. A nonnegative function $g(i, j)$ is said to be Q-superadditive if for all integers $1 \le b \le n < m$,

$$g(b, n) \le g(b, n + 1),$$
$$g(b, n) + g(n + 1, m) \le Qg(b, m),$$

where $1 \le Q < 2$. Clearly, the case $Q = 1$ corresponds to the usual notion of superadditivity. A number of moment as well as probability bounds were proved in [20] for the maximum of partial sums which gave back the previously proved inequalities in the case $Q = 1$.

We also proved moment inequalities for the maxima of the rectangular partial sums of random fields in [16] and [18]; probability inequalities of exponential type in [14], [17], and [19]; and maximal moment as well as probability inequalities for stochastic processes in [22] and [23].

Applications of maximal inequalities to obtain strong laws of large numbers can also be found in [13] and [27] for sequences of random variables; furthermore, in [15], and [18] for quasi-stationary sequences and random fields, respectively.

Finally, we mention that in recent times maximal inequalities are also of use in Numerical Analysis in the study of the convergence of wavelets (see, for example, [11]) as well as in Functional Data Analysis, (see, for example, [5]).

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Author's Note

Ferenc Móricz was born and educated in Hungary, received his BSc, MSc and Ph.D. at the Bolyai Institute of the University of Szeged; the Bolyai Institute was founded by F. Riesz and A. Haar just after the First World War. In 1983 Ferenc Móricz received the Erdős Prize, awarded each year to one of the outstanding Hungarian mathematicians. He earned a Keldysh scholarship and spent one and a half years at the Steklov Mathematical Institute in Moscow; spent a "Sommer Semester" at the University of Ulm, Germany, as a Visiting Professor; and altogether six academic years at the Johns Hopkins University at Baltimore, Indiana University at Bloomington, University of Wisconsin at Madison, Syracuse University, University of Tennessee at Knoxville, and Texas A&M University at College Station, as a Visiting Professor between the years 1981 and 2005.

In Memory of Pierre Lelong

Henri Skoda, Coordinating Editor

A Tribute to Pierre Lelong

Born in Paris on March 14, 1912, Pierre Lelong died also in Paris on October 12, 2011. He was a brilliant student and he was admitted to *Ecole Normale Supérieure* in 1931. He attended the lectures of Professors Arnaud Denjoy and Paul Montel, who was his thesis advisor. He defended his *Thèse d'Etat* in 1941 about the singularities of holomorphic functions of two variables. In 1942, he introduced the class of plurisubharmonic functions which were developed independently by Kiyoshi Oka in Japan in the early 1940s. With these functions, he built a powerful tool in complex analysis in several variables which has been clearly important in the works of many mathematicians such as K. Kodaira, H. Grauert, L. Hörmander, E. Bombieri.

Pierre Lelong taught at the Universities of Grenoble (1943–1945), Lille (1946–1954), and the University of Paris (Sorbonne and Paris 6) until 1981. From 1959 to 1961, he was a very effective advisor of the President of the French Republic Général Charles de Gaulle for scientific research and public education. Pierre Lelong was elected as a member of the French Academy of Sciences in 1985.

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Another article in honor of the memory of Pierre Lelong, with more insight into Pierre Lelong's political action, is available in the journal Normat. *The reference is: Kiselman, Christer O., "Pierre Lelong 1912–2011",* Nordisk matematisk tidskrift, Normat, ***60*** *(2012), no. 2, 70–81 [2014].*

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He made an important contribution to the development of the French school in complex analysis and analytic geometry. One of the last great French mathematicians of the twentieth century has passed away.

Jean-Pierre Demailly

Pierre Lelong: A Foundational Work in Complex Analysis and in Analytic Geometry

My first encounter with Pierre Lelong goes back to 1977, a year during which I started to attend his "Séminaire d'Analyse" in Paris, coorganized in collaboration with Henri Skoda since 1976. During the same year, I also benefitted from a series of lectures that Pierre Lelong gave on the theory of plurisubharmonic functions and positive currents, following a Ph.D. course presented a few months earlier by Henri Skoda at Université Paris VI. These early contacts have had a strong and lasting influence on my scientific career. In fact, my later scientific investigations almost never departed from the fundamental theories initiated by Pierre Lelong during the decades 1940–1950 and 1950–1960 ([4], [5]): these theories have wonderful applications to vast subdomains of mathematics, e.g., in number theory or algebraic geometry. Even though many mathematicians throughout the world have continued exploring these directions in the following decades, most experts would certainly agree that a lot remains to be done today.

A few years later, when I defended my "Thèse de Doctorat d'État" in 1982, I had the privilege of

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being invited to Pierre Lelong's private dwelling in Paris. This was the occasion for me to realize another important aspect of his past activities, namely, his deep commitment to politics, and the guidance he exerted in 1959–1961 during a major reform of higher education and research, as one of the scientific advisors of Géneral de Gaulle, then the president of the French Republic. Especially impressive were Pierre Lelong's private library and the unusual number of books and documents dealing with politics and political science. At present, the French system of higher education is faced with severe difficulties, and I cannot refrain from thinking what a benefit my country had during the 1960s, a period, of course, much more favorable economically, when the scientific policy was guided by such enlightened minds as Pierre Lelong. In fact, France enjoyed at that time a sustained scientific and technological development, as well as a very strong increase of the number of students at universities. One would like to see clearer signs today that the European governments are ready to invest in science and to give it again a prominent role in the evolution of society—and, as a consequence, to rely extensively on the expertise of the scientific community rather than on technocrats!

Even though this is probably not the most central part of Pierre Lelong's scientific work, I would like to discuss here one contribution that has in my view shed light on several important problems. This is a paper entitled "Éléments extrémaux sur le cône des courants positifs fermés" ("Extremal elements in the cone of closed positive currents"), published in the *Séminaire d'Analyse* in 1971/1972 [7]. The first main statement of the paper is:

Theorem 1. *Let M be an analytic set of complex codimension p, assumed to be irreducible, in a connected complex analytic manifold X (countable at infinity). Then the current of integration $[M]$ is extremal in the cone of closed positive currents of bidegree (p,p) in X.*

After stating this result, Pierre Lelong observed that many other examples of closed positive currents that had then been investigated were not extremal, especially those arising from smooth convex functions or smooth plurisubharmonic exhaustion functions like $\log|z|$, and he concluded: "*It is likely that Theorem 1 does not produce all extremal elements in the cone of closed positive currents; this seems to be an important unsolved question of complex geometry*." I still remember a private discussion we had on this issue at Jussieu. Strongly stimulated by these observations and by a further exchange with Jean-Louis Verdier, I realized a couple of weeks later, around the end of 1981, that such a restrictive property concerning extremal elements could not hold. In fact, it would have implied via Choquet's representation theorem a formulation of the Hodge conjecture that was much too strong to be true. Therefore some of the extremal elements must be more complicated than currents of integration on analytic sets, and I found shortly afterwards an explicit example of such an extremal closed positive current of bidegree $(1,1)$ in the complex projective plane [De82]. As first noticed by Eric Bedford, further examples appear in a natural way in complex dynamics of several variables; many invariant closed positive currents produced by complex dynamical systems are actually extremal currents, although their support is in general a fractal set, and therefore is not analytic. This is, for instance, what happens for a current of the form $\lim_{k\to+\infty} d^{-k}\frac{i}{\pi}\partial\overline{\partial}\log|P^k(z)|$, where P^k is the kth iteration of a polynomial endomorphism of degree $d>1$ on projective space, the support of such a current being a Julia set [Sib99]. The dynamical study of "hyperbolic" endomorphisms of certain algebraic surfaces, e.g., K3 surfaces, also leads to such extremal invariant currents [2].

Photo: Christer Kiselman.

Pierre Lelong in Dublin, March 1973.

Another fundamental statement contained in the above-cited article [7] is the following.

Theorem 2. *If G is a pseudoconvex domain in $\mathbb{C}^n$, the positive cone generated over rational coefficients by functions of the form $\log|f|$, where f is holomorphic in G, is dense in the cone of plurisubharmonic functions on G.*

Corollary. *If, moreover, $H^2(G,\mathbb{R})=0$, the positive cone generated over rational coefficients by currents of integration $[D]$ on irreducible divisors of G is dense in the cone of closed positive currents of type $(1,1)$ on G.*

The original proof of Lelong rests upon a use of complex function theory on Hartogs domains of the type $|w|<e^{-\varphi(z)}$, $(z,w)\in\mathbb{C}^n\times\mathbb{C}$. If φ is plurisubharmonic and if z is taken in a pseudoconvex domain G, it is known that the corresponding Hartogs domain in $G\times\mathbb{C}$ is again pseudoconvex; as a consequence, there exists a holomorphic function $F(z,w)$, the domain of existence of which is precisely the Hartogs domain $|w|<e^{-\varphi(z)}$. The approximation of the function φ by logarithms of holomorphic functions $f_j(z)$ is

Photo: H. Skoda.

Pierre Lelong and Henri Cartan in Wimeureux, France, May 1981.

Photo: Christer Kiselman.

Hubert Delange, Philippe Noverraz, and Pierre Lelong in La Jolla, California, July 1966.

then obtained by applying Hadamard's formula to compute the radius of convergence of the power series $\sum_{k\in\mathbb{N}} a_k(z)w^k$ of $F(z,w)$. The corollary is then derived by means of the fundamental "Lelong-Poincaré" equation, stating that for every holomorphic function F the current $\frac{i}{\pi}\partial\overline{\partial}\log|F|$ coincides with the current of integration $[Z_F]$ on the zero divisor of F.

These approximation results for currents are now a central ingredient of modern analytic geometry. By replacing the qualitative existence theorem of defining holomorphic functions and Hadamard's formula with deeper results such as the Ohsawa-Takegoshi L^2 extension theorem ([10]), one can obtain more precise statements in which the multiplicities of the approximating $\mathbb{Q}$-divisors converge uniformly to the "Lelong numbers" of the given closed positive $(1,1)$-current. In that way, one gets a very strong analytic tool that allows one, in particular, to prove numerous geometric results—for instance, Siu's theorem on the analyticity of level sets associated with Lelong numbers of closed positive currents [15]. Another consequence of such techniques in algebraic geometry is the proof of the conjecture on the invariance of plurigenera for deformations of arbitrary nonsingular projective algebraic varieties ([14], [11]); the latter result relies again on the Ohsawa-Takegoshi theorem and on a compactness argument for closed positive currents of type $(1,1)$; it comes as a surprise that no algebraic proof is known at this point in time, although the statement involves only algebraic objects!

Finally, among applications to number theory, one should mention Bombieri's theorem on algebraic values of meromorphic functions of several variables satisfying algebraic differential equations [1], [15], [9]. The proof, here again, exploits in an essential way the compactness properties of closed positive currents of type $(1,1)$ in classes of currents of finite order, in conjunction with Hörmander's L^2 estimates for the $\overline{\partial}$ operator.

Pierre Lelong's clever use of "flexible objects"[1], such as plurisubharmonic functions and positive currents, has permitted the emergence of various important techniques that have led to strong effective formulations of many results in algebraic, analytic, or arithmetic geometry, especially in areas where previously known techniques could only produce qualitative results. Pierre Lelong was perfectly aware of the philosophical dimension of the contributions he made, and he very early set up their most fundamental consequences.

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[1] (*) *"Objets souples", according to the terminology employed by Pierre Lelong himself in his notice of scientific work sent to the Académie des Sciences* [8].

Photo: H. Skoda.

Yum Tong Siu and Pierre Lelong in Paris, September 1997.

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Yum-Tong Siu

Pierre Lelong in Memoriam

After studying his work on closed positive currents in the late 1960s, I had the opportunity of meeting Professor Pierre Lelong in person for the first time in the spring of 1972 when I visited Paris VII for one semester. He was very approachable and humorous. Though at that time I was only a young mathematician, he made me feel completely at ease in our mathematical conversations. Since then I had many occasions to discuss mathematics with him at the meetings of the Lelong-Dolbeault-Skoda Seminar and other mathematics seminars in Paris and in many conferences such as the conference at Poitiers in 1972, the American Mathematical Society's twenty-third summer institute at Williams College in 1975, and Lelong's seventieth birthday conference at Wimereux in 1981. I greatly enjoyed and benefitted from these conversations. Each time not only did I learn to understand better from his perspective and gain more insight into his work, but I also came away with a deepened interest and greater enthusiasm for his theory of closed positive currents. His passion for the subject was infectious.

Lelong has made many pioneering contributions in mathematics. Especially of great impact is his work on the Poincaré-Lelong equation, closed positive currents and Lelong numbers. The best way to understand this very important part of his work is to look at it from the historic perspective of constructing meromorphic functions on abstractly defined complex manifolds and see how his contributions fit in a pivotal way into the global landscape in the theory of several complex variables.

The theory of several complex variables studies complex-analytic objects such as holomorphic and meromorphic functions and maps, complex-analytic subvarieties, holomorphic vector bundles, and coherent analytic sheaves. When a complex-analytic manifold or space is projective algebraic, by definition it is embedded inside a complex projective space and there are many complex-analytic objects on it which are constructed from those on the complex projective space. When a complex-analytic manifold is abstractly defined by piecing together local holomorphic charts, the construction of complex-analytic objects on it is a problem of fundamental importance.

Historically the first breakthrough came in the form of the uniformization theorem for Riemann surfaces which states that a simply connected Riemann surface is biholomorphic to the Riemann sphere, the Gauss plane, or the open unit disk.

In the 1950s and 1960s three important methods of constructing meromorphic and holomorphic functions were introduced: Kodaira's embedding theorem, Grauert's solution of the Levi problem, and the solution of the complex Neumann problem with L^2 estimates of $\bar{\partial}$.

Kodaira's embedding theorem constructed meromorphic functions on so-called Hodge manifolds which are compact complex manifolds carrying some smooth closed positive-definite $(1,1)$-form whose cohomology class is an integer class. Kodaira proved his embedding theorem by using Hopf's blowup of a point and his vanishing theorem obtained by Bochner's technique of completion of squares applied to the quadratic polynomial whose variables are the symbols of the Laplace operator

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Photo: H. Skoda.

Christer Kiselman and Pierre Lelong in Paris, September 1997.

for forms with coefficients in the line bundle with Chern class represented by the given $(1,1)$-form.

Grauert's solution of the Levi problem used his bumping technique to construct holomorphic functions on complex manifolds which admit strictly plurisubharmonic exhaustion functions.

The solution of the complex Neumann problem with L^2 estimates of $\bar\partial$ was developed by C. B. Morrey, Kohn, Hörmander, and others. It produces holomorphic functions, with an additional L^2 growth condition, in a Levi-problem setting by applying the method of Kodaira's vanishing theorem to an open manifold, using Hörmander's modification of Friedrich's density result in the graph norm, and then using Morrey's technique of handling the boundary term by some special integration by parts involving three factors.

The significance of Kodaira's embedding, Grauert's solution of the Levi problem, and the solution of the complex Neumann problem consists in starting with soft objects like positive definite smooth $(1,1)$-forms and plurisubharmonic exhaustion functions and ending up with rigid objects like holomorphic functions.

The importance of Lelong's theory of closed positive currents is that closed positive currents introduced and studied by him are a new class of soft objects from which rigid objects like complex-analytic subvarieties can be constructed with the use of Lelong numbers.

The first step of Lelong's theory of closed positive currents is his result that integration over the regular part of a pure-dimensional complex-analytic subvariety is a closed positive current. For a complex-analytic subvariety V of pure complex codimension p on an open subset G in $\mathbb{C}^n$, he proved that the (p,p)-current $[V]$, which is defined by integrating, over the regular part of V, smooth $(n-p,n-p)$-forms τ with compact support on G, is well defined and is a d-closed current. Moreover, $[V]$ is automatically positive in the sense that its value at τ is nonnegative when τ is of the form $\prod_{j=1}^{n-p}\sqrt{-1}\,\tau_j\wedge\overline{\tau_j}$ for some $(1,0)$-forms τ_j. Lelong realized the importance of singling out the two properties of closedness and positivity for currents and developed his theory of closed positive currents.

The well-definedness and closedness of the current of integration over the regular part of a pure dimensional complex-analytic subvariety makes possible the formulation and the proof of the Poincaré-Lelong equation. In the language of currents, Cauchy's integral formula takes the form of the Poincaré formula $\frac{\sqrt{-1}}{2\pi}\partial\bar\partial\log|z|^2=[0]$, where z is the complex coordinate of $\mathbb{C}$ and $[0]$ is the $(1,1)$-current defined by the evaluation, at the origin, of smooth functions on $\mathbb{C}$ with compact support. Lelong's result on currents defined by integration over regular parts of subvarieties enabled him to obtain the Poincaré-Lelong formula $\frac{\sqrt{-1}}{2\pi}\partial\bar\partial\log|f|^2=[Z]$ on an open subset G of $\mathbb{C}^n$, where f is a holomorphic function on G and its zero-set Z is of generic multiplicity 1. More generally, $\left(\frac{\sqrt{-1}}{2\pi}\partial\bar\partial\log\sum_{j=1}^{p}|f_j|^2\right)^p=[V]$ on any open subset G of $\mathbb{C}^n$, where $f_1,\dots,f_p$ are holomorphic functions on G and their common zero-set V is of complex codimension p and generic multiplicity 1.

The construction of complex-analytic subvarieties from closed positive currents comes from the use of a kind of density number which Lelong introduced and which is now known as Lelong numbers. For a closed positive (p,p)-current Θ on an open neighborhood of a point P in $\mathbb{C}^n$, Lelong defined the Lelong number $n(\Theta,P)$ of Θ at P as the limit of the quotient of the total mass of Θ on the ball of radius r in $\mathbb{C}^n$ by the volume of a ball of radius r in $\mathbb{C}^{n-p}$. It is a number describing the density of the closed positive current Θ near the point P. The motivation of the Lelong number comes from the special case when Θ is the current $[V]$ defined by integration over the regular part of a complex-analytic subvariety V of pure complex codimension p and the Lelong number $n([V],P)$ is the multiplicity of V at P.

The significance of Lelong numbers is that their super-level sets are closely related to complex-analytic subsets. Here a super-level set means a set consisting of all points where the value of the Lelong number is no less than a certain positive number. The first important application of the concept of Lelong numbers is Bombieri's generalization, to the higher-dimensional case by using L^2 estimates of $\bar\partial$, of the solution of the seventh problem of Hilbert by Gelfond and Schneider.

Later Lelong's student Skoda and other mathematicians followed in his footsteps to develop further his theory of closed positive current. Now

a precise form of the relation between super-level sets of Lelong numbers and complex-analytic subsets is the result that for any positive number c the set of points P with $n(\Theta, P) \geq c$ is a complex-analytic subvariety of complex codimension $\geq p$ for any closed positive (p,p)-current Θ.

The theory of closed positive currents is a common platform with links to the historic electrostatic potential method, Kodaira's vanishing theorem, and L^2 estimates of $\bar{\partial}$. This role of the theory of closed positive currents can be most easily seen by starting with a closer look at the historic electrostatic potential method of constructing meromorphic functions on Riemann surfaces in the proof of the uniformization theorem.

The electrostatic potential method starts with an electric charge on a Riemann surface X at a point P of X. The electrostatic potential u on the Riemann surface due to the charge is constructed by minimizing the Dirichlet integral which is modified by the offset of a local electrostatic potential near P. The modification means subtracting from the test function an electrostatic potential on a coordinate disk centered at P with vanishing boundary normal derivative and then forming the Dirichlet integral on X minus the boundary of the coordinate disk. The vanishing of the boundary normal derivative of the local electrostatic potential corresponds to the Weierstrass-Erdmann corner condition in calculus of variations. The result u of minimization is independent of the choice of the local coordinate disk centered at P and the local offset electrostatic potential on it.

When the Riemann surface X is simply connected, the normalization of the charge is chosen so that the meromorphic function whose real part is the electrostatic potential u has a simple pole at P. This meromorphic function gives a biholomorphic map from the Riemann surface onto the entire Riemann sphere or the complement of a point or a slit in it. The local biholomorphic property of the map comes from the motivation that electric field lines outside the charge cannot intersect. The injectivity and the surjectivity onto the desired image come from the fact that domains bounded by equipotential lines and field lines must contain P in their topological closures due to the minimizing of the Dirichlet integral with offset by the electrostatic potential.

There is another approach to the uniformization theorem for Riemann surfaces which uses the Riemann mapping theorem, the Schwarz reflection principle, and Koebe's distortion theorem. Unlike the approach by electrostatic potential which allows the replacement of the charge by a closed positive current in its higher-dimensional analogue, this other approach cannot be extended for use in the construction of holomorphic objects on higher-dimensional complex manifolds.

Photo: Christer Kiselman.

Pierre Lelong and Jean-Baptiste Poly in Paris, June 1972.

In the language of closed positive currents, for the case of the Riemann surface X being the increasing union of relatively compact simply connected subdomains X_ν, the potential u can be obtained as the limit of u_ν which satisfies $\frac{\sqrt{-1}}{2\pi}\,\partial\bar{\partial}u_\nu = -[P]$ on X_ν with the vanishing of the normal derivative of u_ν at the boundary of X_ν. This is a consequence of the Weierstrass-Erdmann corner condition and the independence of u on the choice of the coordinate disk at P. This formulation in the language of closed positive currents shares the complex Neumann condition of vanishing of boundary normal derivative with the L^2 estimates of $\bar{\partial}$ in the solution of the complex Neumann problem. One of the crucial steps of the latter is Morrey's trick of using the complex Neumann boundary condition to handle the boundary term.

The Poincaré-Lelong equation suggests that, when the open Riemann surface X is replaced by a noncompact complete Kähler manifold Y with X_ν replaced by a geodesic ball Y_ν of Y, the $(1,1)$-current $[P]$ defined by the charge at P should be replaced by $[V]$ for some subvariety V of pure complex codimension p. The electrostatic potential u as the limit of u_ν is to be replaced by the limit of v_ν which satisfies the equation $\left(\frac{\sqrt{-1}}{2\pi}\,\partial\bar{\partial}v_\nu\right)^p = [V]$ on Y_ν with the vanishing of the normal derivative of v_ν at the boundary Y_ν. This partial differential equation is nonlinear for $p > 1$.

For this setting Lelong's student Skoda used a related, but simpler, linear differential equation and with the use of L^2 estimates of $\bar{\partial}$, constructed, from a complex-subvariety V of pure complex codimension p in $\mathbb{C}^n$ with volume growth condition, global holomorphic functions on $\mathbb{C}^n$ with L^2 growth condition whose common zero-set is V. In the general case, with $[V]$ replaced by a a closed positive (p,p)-current Θ, the linear differential

Photo: Christer Kiselman.

Klas Diederich, Doris Lindner, Pierre Lelong, and Hung-Hsi Wu in Wuppertal, 1986.

equation used by Skoda equates the Laplacian of the unknown function U to the trace measure of Θ. He then modified U by a continuous function to get a plurisubharmonic function ψ which he used with the method of L^2 estimates of $\bar{\partial}$ to produce his holomorphic functions. The hard analysis developed in Skoda's construction of the plurisubharmonic function ψ from the closed positive current Θ provided many essential tools for the complex-analyticity of super-level sets of closed positive currents.

The method of Kodaira's vanishing theorem uses the smooth strictly positive $(1,1)$-form ω on a compact complex manifold which satisfies $\omega = \frac{\sqrt{-1}}{2\pi}\partial\bar{\partial}\varphi$, where $e^{-\varphi}$ is the smooth metric of a holomorphic line bundle. This is analogous to the differential equation for electrostatic potential in the uniformization theorem and to the differential equation in the higher-dimensional case for a closed positive $(1,1)$-current. One difference in this analogy is that, in the setting of the uniformization theorem and the higher-dimensional situation, the manifold is noncompact and the line bundle is trivial. With the use of Lelong's theory of closed positive currents, the method of Kodaira's vanishing theorem can be generalized to the case where ω is a closed positive $(1,1)$-current which is strictly positive in the sense that it dominates some smooth positive $(1,1)$-form in the sense of currents. Now the metric $e^{-\varphi}$ is allowed to be nonsmooth so that φ behaves like a plurisubharmonic function plus a smooth function. This generalization yielded Nadel's vanishing theorem with multiplier ideal sheaves, whose analogue in the setting of algebraic geometry is reduced to the vanishing theorem of Kawamata-Viehweg. In the 1990s the vanishing theorem for multiplier ideal sheaves was applied by Ein-Lazarsfeld, Demailly, and many others to obtain a wide range of effective results in algebraic geometry. Coupled with the use of the extension theorem of Ohsawa-Takegoshi, the vanishing theorem for multiplier ideal sheaves led also to the proof of the long-conjectured deformational invariance of plurigenera in algebraic geometry and the solution of other problems in algebraic geometry. All of these developments in the last couple of decades depend indispensably on the tools from Lelong's theory of closed positive currents.

Lelong's legacy of the theory of closed positive currents is really an amazing piece of the global jigsaw puzzle in the development of several complex variables. Without doubt it will continue to open up new vistas of research and provide ever deeper insight into the many diverse techniques in several complex variables and related fields.

Henri Skoda

Pierre Lelong: A Mathematician and a Man Deeply Committed to Serving His Country

It was not long before the events of May 1968 that I first met Pierre Lelong, at the seminar he organized jointly with François Norguet at the Institute Henri Poincaré. I was then an advanced student preparing my thesis under the supervision of André Martineau who had advised me to attend it so that I could observe "the state of the art" in the field of holomorphic functions of several complex variables. At that time, there were no individual computers nor Web. Papers were typewritten with carbon copies. Phone and television were still luxuries. So seminars were a more important place to interchange ideas and results between mathematicians than nowadays. They were fewer, and the audience of the P. Lelong and F. Norguet seminar was very impressive because of the quality and the number of its members. For instance, Henri Cartan regularly attended it. As early as October 1968, I began to study P. Lelong's works, especially those on the zeros of entire functions in $\mathbb{C}^n$. I discovered in them, on the one hand, the detailed study of the properties of the plurisubharmonic functions family ([Le 45]) (that is, the function is uppersemicontinuous and its restriction to every complex line is subharmonic), which included both convex functions and $\log|f|$ functions where f is a holomorphic function. On the other hand, as early as 1953, P. Lelong ([8]) had proved that the current of integration on a complex analytic set was well defined. In spite of the singularities of the analytic set, this current was closed. The apparent positivity of this current ([10]) (in the sense that all the measures naturally associated with that current by the complex structure were positive) led Pierre Lelong to introduce the concept of positive current. The multiplicity of the current of integration on an analytic set at a point also led P. Lelong to define, more generally, the density of a positive closed current at a point. The density was subsequently called the Lelong number of the current. In the same way as that of Laurent

Schwartz distributions or G. de Rham currents, it gave the possibility of dealing with the analytic sets of complex geometry with analytic methods totally compatible with the algebraic method of sheaf theory and of local algebra and especially well adapted to the study of metric and quantitative properties of analytic sets. The most important part of my work is immediately connected with the concepts P. Lelong introduced. In my inaugural lecture at Colloque Européen en l'honneur de Pierre Lelong, in September 1997 ([19]), I had already widely explained the notable impact of these concepts on the development of complex analysis in several variables and on algebraic geometry on the field of complex numbers from 1940 to 1997. This in relation with Lars Hörmander ([5]), ([6]) and Enrico Bombieri ([1]) L^2 estimates for the $\bar\partial$ operator in 1965, then with the Ohsawa-Takegoshi ([12]) extension theorem and that of coherence from A. M. Nadel ([11]). All these results are themselves based on the notion of plurisubharmonic function as well as on a long mathematical tradition in the fields of partial differential equations and of differential geometry. In short, mathematicians could from that time on use an extremely effective machinery: by the means of a convenient integral kernel, it was possible to assign a plurisubharmonic function and then an analytic set to every closed positive current so that this analytic set was closely connected with the structure of the given current.

In this collective tribute, other mathematicians analyze this aspect of things. I would like to bring to light other aspects which are perhaps less well known. Pierre Lelong had built, as early as 1956 ([9]), the equivalent in $\mathbb{C}^n$ of the canonical Weierstrass product (that is, a holomorphic function F of minimal growth vanishing on a given zeros set) as a plurisubharmonic potential $\log|F|$ solving in $\mathbb{C}^n$, in a very modern and inventive way, in the spirit of Hodge theory, the so-called (today) Lelong-Poincaré equation: $\frac{i}{\pi}\partial\bar\partial \log|F| = [X]$ where $[X]$ is the current of integration on the hypersurface X. In my thesis in 1972 ([17]), I benefitted from all of these methods dealing with potential theory and L^2 estimates to extend this work of P. Lelong about hypersurfaces of $\mathbb{C}^n$ to any analytic set.

Then, in 1975, going back again to the solving of the same equation, Gennadi Henkin and I ([13]) were independently successful in characterizing the zeros of Nevanlinna class functions in bounded smooth strictly pseudoconvex domains of $\mathbb{C}^n$ by the Blaschke condition. In the same way, we more generally have solved the equation $\frac{i}{\pi}\partial\bar\partial V = T$ where T is a closed positive current verifying the Blaschke condition.

P. Lelong's views have taken a prominent role in the following way: let ρ be a smooth strictly plurisubharmonic function defining the bounded open set $\Omega = \{z \in \mathbb{C}^n; \rho(z) < 0\}$. The Blaschke condition on T can be written as $\int_\Omega -\rho(i\partial\bar\partial\rho)^{n-1}\wedge T < +\infty$ and Stokes's formula provides the following equality: $\int_\Omega -\rho(i\partial\bar\partial\rho)^{n-1}\wedge T = \int_\Omega (i\partial\rho\wedge\bar\partial\rho)\wedge(i\partial\bar\partial\rho)^{n-2}\wedge T < +\infty$. This means that the complex tangential component of T, $(i\partial\rho\wedge\bar\partial\rho)\wedge T$, has finite mass in Ω, hence it satisfies something stronger than the Blaschke condition. This strong condition on the behavior at the boundary of the complex tangential component of T was the first compulsory and decisive step to solving the equation $\frac{i}{\pi}\partial\bar\partial V = T$ with the expected Nevanlinna estimate $\sup_{\epsilon>0}\int_{\rho(z)=-\epsilon} V^+ < +\infty$. That kind of strong estimate of the complex tangential component of a closed positive current remains today as an essential argument in the numerous researches on hard analysis about zeros of functions in Hardy classes on pseudoconvex domains.

Photo: L. Gruman.

Christer Kiselman, Kiselman's wife Astrid, Bo Berndtsson, Pierre Lelong, Kiselman's son Ola, Sweden, 1981.

In the 1950s and 1960s, P. Lelong's ideas seemed to be very useful to control the asymptotic behavior of holomorphic objects. P. Lelong had observed that Hadamard's inequality of convexity generalized to holomorphic functions of several variables had much deeper consequences than with one variable. It implies, for instance, that the asymptotic behavior at infinity of an entire function is remarkably stable along almost all complex lines. That has been the decisive argument which was used to build ([18]) examples of holomorphic fiber spaces, with Stein ($\mathbb{C}^2$) fiber and with Stein basis (an open subset

of $\mathbb{C}$) but which are not Stein. It gave a negative answer to a question of Jean-Pierre Serre which has aroused the curiosity of geometers for many years. Indeed the fiber bundle is built in such a way that the action of the transition automorphisms on the fibers contradicts the consequences of the Lelong-Hadamard inequality on the growth alongside the fibers of a holomorphic function globally defined on the total space. Such a function has to be constant on the fibers and the total fiberspace is far from being Stein. This successful construction has shown that P. Lelong's methods could be more effective for strictly geometrical problems than the more traditional sheaf theoretic methods.

By chance or destiny, and probably with the help of Jean-Louis Verdier, Directeur des Études at École Normale Supérieure and Michel Hervé, Directeur Adjoint of École Normale Supérieure, one of the first who attended my lessons for advanced studies in 1976 was Jean-Pierre Demailly, a young student who was also raised on P. Lelong and L. Hörmander's methods. He immediately took up the torch by extending and making more flexible the notion of the Lelong number ([3]) and connecting it with other important problems of that time such as the Hodge conjecture ([2]) and numerical vanishing theorems. From that time forward, P. Lelong's ideas were far from seeing their end. More and more mathematicians took interest in studying his works, which had also a decisive impact on other fields, such as algebraic geometry with, for instance, the deep results of J. P. Demailly on the Fujita conjecture ([4]) and Y. T. Siu' s proof ([16]) of the invariance of plurigenera. Let us quote too the emergence of closed positive currents in the holomorphic dynamic systems with several variables, following Eric Bedford's and Nessim Sibony's works ([14]). I am grateful to Pierre Lelong for having, in an unpretentious way, laid the bases of all these mathematical developments which, I think, are far from over.

I would like now to throw light on his seminar, which became an important part of scientific life. Many French or foreign researchers were invited and benefitted from being in his audience and the broadcasting of the talks, which were published in "Seminar Acts", by Springer, between 1957 and 1986, in the *Lecture Notes Series*. Pierre Lelong, Pierre Dolbeault and I have shared the managing of the Complex Analysis Seminar which continues to the present day. Gennadi Henkin and Jean-Marie Trépreau have taken part in the seminar management. From October 2006, with the arrival of Olivier Bicquard and Tien Cong Dinh, it has become the Geometry and Complex Analysis Seminar and has quite turned to differential geometry, dealing, however, with an important part of complex analysis. From time to time, Henri Cartan and Laurent Schwartz attended the seminar, and more regularly Paul Malliavin and Michel Hervé. In organizing it, we could talk not only about mathematics, research, and university, but also about the part involving administration and state in the research field.

I immediately saw in P. Lelong's speech and individual characteristics the mark of the humanist tradition, reinforced by his classical studies in secondary school, which gives more importance to man than to ideology and technology. It was in that way P. Lelong undertook to serve the state. He trained for public service for a long time, by attending, in the 1930s, the Institut Politique de Paris, in addition to his mathematical activities. In the 1960s, he became a scientific consultant of the president of the French Republic, Général Charles de Gaulle, and so he gave a contribution to the effort for the expansion of universities and planning for research. He especially contributed to the expansion of computer science in France with the establishment of INRIA. I think his influence has been highly beneficial and we owe him much still today. He also tried, during the 1980s, to protect the Institute Henri Poincaré (IHP). For, because of a legal vacuum, mathematicians could have been excluded from this institute. He did his best to obtain clear statutes for IHP, acting in the best interest of mathematicians and theoretical physicists.

I wish to pay tribute to the memory of Pierre Lelong. One of the best mathematicians of the twentieth century has left us, whose influence will go on for a long time, but who was also an academic deeply wedded to humanistic values and to funding the values of the French Republic.

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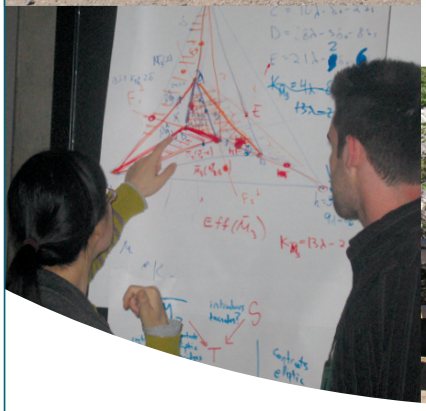

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Some Thoughts on the Teaching of Mathematics—Ten Years Later

Igor Rivin

This is a somewhat expanded and corrected version of a "manifesto" first posted on my Temple University webpage almost exactly ten years ago. Since then, I have put some of the ideas expressed below into practice—a brief description of my experience is included in the section "My Experience over the Last Decade"—and I have also had a fair amount of feedback. Some (most) of it has been completely positive; other feedback has included some critical ideas. I describe some of it in the section "Some Feedback".

What Is the Problem?

A mathematics professor in a public university has many responsibilities. These include research, administration, and teaching. Teaching, in turn, includes "specialized" teaching (to mathematics majors and graduate students) and "service" teaching: teaching mathematics to first and second year students. These thoughts will center primarily on service teaching which, for me, combines some of the most exciting and some of the most depressing aspects of my job. Some thoughts on teaching mathematics majors are added in the section "What Can We Do?".

The Product

Why depressing? Consider the following: the vast majority of service courses are concerned with differential and integral calculus and linear algebra. These are both rather deep subjects, as evidenced by the fact that mathematics had been practiced for thousands of years by rather talented people before the basic principles of the calculus were laid down in the late seventeenth century (although some of these principles were discovered, in an *ad hoc* way, by Archimedes—considerably earlier). It took another two hundred years of extensive work to make the foundations of the subject truly solid. Linear algebra, as used today, is an even later bloomer. The current machinery of matrices and linear transformations was not put into a truly modern form until the beginning of the twentieth century. We have no choice but to agree that these subjects are quite deep and require some considerable technical skill to use successfully.

The Consumers

Who are we teaching them to? In a public university (such as Temple) our students are, in the main, somewhat above average products of the U.S. public secondary education system. This means that their technical ability is already quite severely taxed by arithmetic with fractions. Their abstract reasoning skills are essentially nonexistent and the very concept of proof is foreign to them.

The Results

A consequence of all this is that it is well-nigh *impossible* to teach them what we purport to teach them: higher mathematics presupposes a certain level of abstraction, and even if we commit the crime of forgetting that and define calculus as "a collection of computational techniques without understanding," the students' technical weakness renders even that aspect essentially worthless. They *cannot* compute. The result is that our calculus and linear algebra classes consist of a collection of trivial examples, which the students must memorize by rote. This has the consequence of not teaching the students anything except the fear and hatred of mathematics. There is more still: the majority of the students never use calculus in their future lives (small wonder since they don't actually know any, as discussed above), but they never had any intention of using advanced

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mathematics even *before* taking the courses. They are required to take the courses because of the (not unreasonable) belief that mathematics should be a part of every college-educated person's intellectual makeup. The result is that the *loathing* of mathematics is part of the intellectual make-up of a sizeable majority of Americans. The amazing (and exhilarating) observation is that, despite all of the above, some students actually manage to understand something of the subject. This exhilaration is, however, tempered by thoughts of the huge amount of wasted time and by the thought of what these talented students could achieve if taught properly.[1]

What Can We Do?

What, then, is the solution? We could drop the distribution requirements in mathematics (and I could easily see this happening), but the fact of the matter is that the ability to reason logically and abstractly really should be something (perhaps the *main* thing) everyone takes from his or her higher education and something we, as mathematics educators (which we are, even if the term does produce a visceral reaction in most people), ought to instill in our students. How? The first step is a step back—a step back from "higher" mathematics, the mathematics of the infinite and the infinitesimal—back to conceptually simpler forms of mathematics.

In the (not so distant) past, Euclidean geometry was such a subject, taught exactly for the above-stated reasons (the fundamental concepts—of line, circle, distance, etc.—are quite intuitive, while the basic components of mathematical reasoning are all present). I would not necessarily advocate a return to this, however. Firstly, the subject has been dead for several hundred years, and secondly, it is quite far from the modern American experience.

Instead, it is my opinion that we should start at the very beginning—with reasoning (logic) and counting (which means naive set theory and combinatorics and graph theory) and probability. These subjects are ever more visibly important in our lives due to the ubiquity of computers. They are both easier to learn and more immediately rewarding for the students than what we are currently teaching. In addition, there is another principle which can be used to clear at least some of the mush out of the students' minds. That principle is

(1) A COMPUTER PROGRAM *IS* A PROOF.

For example, the student who wrote the program in the section "Source Code for a Modular Arithmetic Package in Scheme" had to have complete understanding of the Chinese Remainder Theorem, and his program *is* the Chinese Remainder Theorem in that, given some quantities satisfying the hypotheses of the theorem, it never fails to produce a quantity satisfying the conclusion.

This correspondence between program and proof (though far from perfect) allows us to make mathematics hands on (programming a computer gives very rapid feedback, both positive and negative); it is closely related to the students' experience and visibly "useful". (Of course, the real utility of mathematics lies much deeper, but ….)

One problem with this approach is the potential need to waste a lot of time introducing students to the subtleties and idiosyncrasies of some (possibly proprietary) programming language or a scientific computing system. It is important to start the students off on a mathematically clean system, preferably running on a mathematical *abstract machine*. Luckily, such a system is available and had been used for over thirty years in computer science education at MIT, the University of Indiana, and many other schools. This is the Scheme programming language.[2] The justly acclaimed book *Structure and Interpretation of Computer Programs* [1] by H. Abelson and G. J. Sussman introduces the fundamentals of computer programming and, together with a companion book on *Structure and Interpretation of Mathematics*,[3] this would constitute the core of a modern introduction to mathematics. It should be noted that Scheme is no longer used as the introduction to computing at MIT, having been supplanted by Python, but the reason for this is that Python is a more useful tool for practical work (having libraries for almost any task one might need to accomplish) and has absorbed much of the Scheme semantics. It is, however, worse as a first language because it is less pure and has less well-defined semantics.

Given the very high level of functionality presented by Python, Mathematica, or other "kitchen sink" languages, it may be a reasonable compromise to start with Scheme as a way of building a foundation and then proceeding to use one of these languages when (more precisely, when and if) more advanced topics in mathematics need to be introduced.

[1] *A typical cafe conversation usually starts with:*
NONMATHEMATICIAN: *What do you do?*
MATHEMATICIAN: *I study mathematics.*
NONMATHEMATICIAN *(one of these two responses) I am terrible at math OR I used to love math!*
This is a very American phenomenon; I have never had such a conversation in Europe.

[2] *See* `http://scheme.org` *for more details.*

[3] *Writing such a book is a project I am very keen on, but this has to be done in parallel with using these ideas in teaching—the book of Abelson and Sussman was circulated as lecture notes for several years.*

Possible Objections

One could foresee some objections to the above program:

But What about Calculus?

There is no suggestion of eliminating calculus completely from the university curriculum: students of the sciences and engineering (not to mention mathematics) do need to be acquainted with it. However, it would enter somewhat later, when the students are more mathematically mature and thus more capable of actually understanding something of the subject. It is true that a lot fewer students will be *required* to study calculus but, on the other hand, the number of people studying mathematics may actually increase.

But What about the Teachers?

It has been my observation that many of the TAs, having been educated in a "traditional" way, are a little rusty on "finite" mathematics. The same is true (in spades) for many of the professors. Many faculty members and graduate students have no familiarity with computer programming at all. The first problem is easily fixable, the second slightly less so, but my contention is that anything that is teachable to freshmen should be even easier to teach to faculty (and is no less useful to them).

My Experience over the Last Decade

Since the first version of this document was published, I have taught a number of relevant courses (with multiplicity). One was Junior Problem Solving, which is an introductory course in mathematics for computer science majors. Another was Mathematical Patterns, which is a sort of a Math for Poets course. A third was Senior Problem Solving, which is (in principle) the last mathematics course a mathematics major at Temple takes. The fourth was Mathematical Computing—a course for mathematics graduate students.

Poets

In the first two courses (Junior Problem Solving and Mathematical Patterns) I taught the basics of logic, as presented in the very nice book [2] by Harry Gensler, who is an ethical philosopher, not a mathematician. This means, in particular, that while the book eventually goes into symbolic logic, even there a lot of the questions are about deciding validity of English sentences or (more generally) philosophical arguments. In both instances, the course was a success in that, while, as far as I could tell, *none* of the students could carry out a logical argument at the start of the course, *many* could at the end (the fact that they could not at the beginning validates my belief that the students were not ready for anything resembling calculus). Some additional remarks:

- At one point in the Junior Problem Solving course, I decided to try something more "mathematical", and presented the proof that $\sqrt{2}$ is irrational. Despite going very slowly, it was quite clear that the arithmetic involved was too much for the students.
- Many of the students thanked me at the end of the course (in one case, I was walking down the street in Center City, Philadelphia, when one of my former students crossed the street, dodging a number of fast-moving cars, to tell me how much she appreciated the material). This sort of thing had never happened at the conclusion of any calculus course I had taught before.

Budding Mathematicians

In the graduate course, I started by teaching the elements of programming à la Abelson-Sussman, with more emphasis on mathematical problems. The experience was definitely bimodal. The good students (by which I mean ones having a lot of mathematical potential) had extremely good programming skills, while the not-so-good students had essentially none. This, of course, is quite unfortunate since most of Temple's Ph.D. candidates would wind up in industry, which means that programming skills are essential to their future livelihood—the best students are the ones most likely to pursue a career in pure mathematics and, in that sense, *need* programming skills the least (although, as Gauss already knew well, mathematics is an experimental science, and computing is the experiment).

The Senior Problem Solving course was, in a way, the most disappointing—while some of the students were extremely good, most did not have much better technical skills than the computer science students in Junior Problem Solving (to make it more depressing, these were mostly mathematics education majors) and would tend to get just as confused by proofs, especially ones which required computation. I am quite sure that had they been required to take a course of the kind I was teaching to their poetical brethren, together with a rigorous algebra course (of the sort those of us who grew up in the Soviet Union took at the age of twelve), they would have been much more deserving of a mathematics degree. However, by the time I got them, it was already too late.

Source Code for a Modular Arithmetic Package in Scheme

The code below (taken verbatim from a homework assignment done by a student in one of my classes) defines all of modular arithmetic in Scheme (which

already has most of it, so such a program would be a lot shorter and more efficient in practice). At the end, an implementation of the extended Euclidean algorithm is given, followed by an implementation of the Chinese Remainder Theorem algorithm.

```
(define (intMod k m)
  (if (= m 0)
      (lambda (s) 0)
      (let* ((j (remainder k m))
             (l (if (< j 0)
                    (+ j m)
                    j)))
        (lambda (s)
          (if s
              l
              m)))))

(define (sameMod? x y)
  (= (x #f) (y #f)))

(define (eqM? x y)
  (and (= (x #f) (y #f))
       (= (x #t) (y #t))))

(define (displayM x)
  (display (x #t))
  (display " mod ")
  (display (x #f))
  (display "\n"))

(define (+M x y)
  (if (sameMod? x y)
      (intMod (+ (x #t) (y #t)) (x #f))
      (intMod 0 0)))

(define (-M x y)
  (if (sameMod? x y)
      (intMod (- (x #t) (y #t)) (x #f))
      (intMod 0 0)))

(define (*M x y)
  (if (sameMod? x y)
      (intMod (* (x #t) (y #t)) (x #f))
      (intMod 0 0)))

(define (Modulus x)
  (x #f))
```

```
(define (Coset x)
  (x #t))

(define (gcde a b)
  (letrec ((aux (lambda (x1 x2 y1 y2 r1 r2)
                  (let ((r3 (remainder r1 r2)) (q (quotient r1 r2)))
                    (if (= r3 0)
                        (list r2 x2 y2)
                        (aux x2
                             (- x1 (* q x2))
                             y2
                             (- y1 (* q y2))
                             r2
                             r3))))))
    (aux 1 0 0 1 a b)))

(define (/M x y)
  (let ((z (apply gcde (list (y #t) (y #f)))))
  (if (and (sameMod? x y) (= 0 (remainder (x #t) (car z))))
      (intMod (* (cadr z) (/ (x #t) (car z))) (x #f))
      (intMod 0 0))))


(define (crt l)
  (if (null? (cdr l))
      (car l)
      (let* ((w (map Coset (list (cadr l) (car l))))
             (x (map Modulus (list (car l) (cadr l))))
             (y (apply gcde x))
             (z (car y)))
        (if (apply = (map remainder w (list z z)))
            (crt (cons
                  (intMod (/ (apply + (map * w x (cdr y))) z)
                          (/ (apply * x) z))
                  (cddr l)))
            (intMod 0 0)))))
```

Some Feedback

Most feedback has been overwhelmingly positive. Here are some examples and some comments of my own ([IR]):

IR: Some have suggested probability as a good introduction to discrete math. Ward and Gundlach (of Purdue) have written a book for the purpose.

- I read your diatribe and found it very compelling—in fact, something that I agree with and find in accordance with my own experience as an undergraduate (an electrical engineering major). It wasn't until I took a discrete mathematics course in my sophomore year that I began to understand mathematics. I'm now at Caltech studying applied math, so to say that discrete math was the start of an enormous change in my career path would not be an understatement.

  At the same time, you will experience a large number of engineers who feel that a lack of, say, vector calculus in three dimensions will seriously hinder students in (say) electromagnetic engineering. I found this to be the case even though I had taken the course and ostensibly "knew" the material.

[IR]: Of course, I certainly agree that engineers should study multivariate calculus, but not as the first thing.

IR: It was suggested that the "integrated approach" (where mathematics and the science that uses it are used in parallel) is a solution to some of the problems I am trying to address. My view on this is that, while this is an excellent idea, it cannot also be done in parallel to teaching people to think.

- (from a chemist at Temple):

  Hey, I was reading the first part of your diatribe on mathematics education and so far I agree with everything you said. I feel the same way about teaching organic chemistry—I feel like the course is more about identifying the 5% of the population that can handle organic chemistry than teaching.

- (from an applied mathematician friend):

  So I ask you:

  What is the value of an education system which starts at "the very beginning" at eighteen years old ?

  [IR]: My answer is: Very little.

  So. Can we do better? The answer is *yes*. Google Montessori. Both of my children spent from age three to age twelve in Montessori schools. When I try to explain any logical arguments to them, they look at me as if I am a complete moron because by age twelve in a Montessori system logical reasoning is natural.

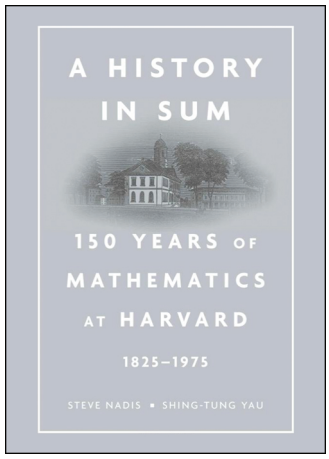
References

[1] Harold Abelson and Gerald Jay Sussman, *Structure and Interpretation of Computer Programs*, Taylor & Francis.

[2] Harry J Gensler, *Introduction to Logic*, Routledge, 2010.

A History in Sum

Reviewed by Steve Batterson



A History in Sum: 150 Years of Mathematics at Harvard (1825–1975)
Steve Nadis and Shing-Tung Yau
Harvard University Press, October 2013
280 pages, $39.95
ISBN-13: 978-06747-250-03

Mathematicians may be surprised by 1982 Fields Medalist Shing-Tung Yau's collaboration with science writer Steve Nadis on a history of the Harvard mathematics department. Perhaps anticipating some bewilderment, Yau begins his portion of the preface with a justification of why history is important to mathematics. For the purposes of this review, I regard historical value as an axiom.

A History in Sum joins Cal Moore's *Mathematics at Berkeley* in the genre of book-length histories of American mathematics departments. Although both volumes are dominated by biographies of university faculty, their underlying methodologies and objectives are very different. Moore wrote what might be classified as a traditional history. He excavated the Berkeley archives and produced a detailed record of the scholarly advancement of the department since the founding of the University of California in 1868. His narrative includes the basic vitae of every faculty member and much more, analyzing changes in the department over the years.

Nadis and Yau focus on the stories of Harvard personnel making pioneering mathematical discoveries. *A History in Sum* features biographies of fourteen Harvard faculty, from the period 1825–1975, "that made the greatest contributions to mathematics." Spoiler alert: If you would like to make your own selections, the names are listed two paragraphs below. In fleshing out these lives, the authors rely on interviews and published material rather than archival sources. As in their first book, *The Shape of Inner Space*, Nadis and Yau set out to make deep mathematics accessible. This time, instead of string theory, the topics range over the various breakthroughs of their stars.

Some readers will have opinions on the merits of a comprehensive departmental history versus singling out its greatest men (at Harvard they are all men). I welcome both approaches as valuable additions to the literature, particularly in view of the distinction of the Harvard and Berkeley departments. In the interest of full disclosure, I need to state that I received honoraria from Harvard University Press for commenting on the manuscript at two stages of its development.

The division of labor between the two authors is not discussed beyond that the initiative arose from Yau. One assumes that Yau selected the names. His bona fides confer special interest on what, in itself, is an intriguing list: Benjamin Peirce, Osgood, Bôcher, G. D. Birkhoff, Morse, Whitney, Mac Lane, Ahlfors, Mackey, Gleason, Zariski, Brauer, Bott, and Tate. Yau acknowledges an element of subjectivity in making difficult decisions about whom to include. While he understandably does not discuss specific omissions, consider some of the Harvard mathematicians who are not featured in the book. Fields Medalists Mumford and Hironaka, whose careers may have been regarded as too late, get some attention as students of Zariski. Joseph Walsh and Marshall Stone receive a mere paragraph apiece, comparable to Moore's coverage of Annie Dale Biddle Andrews, an obscure Berkeley instructor terminated in 1933. Dunham Jackson,

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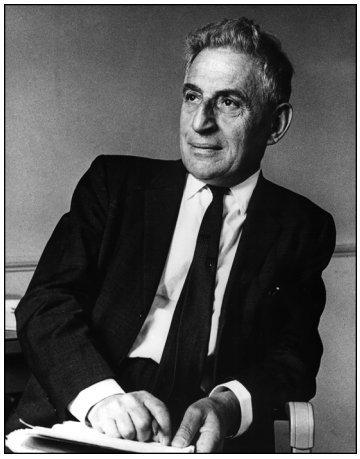

Photo: AMS Archives.

Oscar Zariski

who served on the Harvard faculty from 1911 until leaving for Minnesota in 1919, is not mentioned.

The fourteen biographies average about a dozen pages each, touching on both personal and mathematical lives. My prior knowledge of the individual subjects varied substantially. To my surprise, I was most fascinated by the story of Oscar Zariski, about whom I knew little.

Zariski was born at the end of the nineteenth century in a Russian city that is now part of Belarus. For his education he moved to the Ukraine, where World War I and then the Russian Revolution unfolded around him. In 1919 Zariski was wounded by shrapnel when he happened into a skirmish between Bolshevik and Ukrainian forces. Two years later he left embattled Kiev to continue his mathematical education in Italy.

In Rome, Zariski came under the influence of the pioneering algebraic geometers Guido Castelnuovo, Federigo Enriques, and Francesco Severi. As was characteristic of his life, Zariski made the most of the opportunities in an environment with monumental barriers. Despite being a Communist Jew in a time and place where Mussolini was advancing his fascist agenda, Zariski absorbed the classical techniques of his Italian teachers. He completed his Ph.D. in 1924 under Castelnuovo.

Zariski was fortunate in that, of the Italian geometers, Castelnuovo recognized the limitations of the Italian school. He encouraged Zariski to study the topological techniques being introduced by Solomon Lefschetz. Lefschetz, himself a Russian Jew, had just moved from the University of Kansas to Princeton. Lefschetz used his influence to assist Zariski in obtaining a research fellowship for 1927–1928 at nearby Johns Hopkins.

At Hopkins, Zariski came into his own as an independent scholar, earning a position on the faculty. In preparing his comprehensive text *Algebraic Surfaces*, Zariski gradually realized that the entire subject of algebraic geometry rested on a wobbly geometric foundation. As he began to craft a more rigorous algebraic replacement, a fortuitous opportunity arose. When the Institute for Advanced Study opened in 1933, his Johns Hopkins colleague Egbert van Kampen was part of an experiment in which several promising mathematicians spent a year in residence. The trial was so successful that the president of Hopkins agreed to provide full support for Zariski to visit the institute for 1934–1935. In that same year Emmy Noether commuted to Princeton from Bryn Mawr, delivering lectures on some of the algebraic structures that Zariski needed.

In 1945 Zariski made the most of a posting as an exchange professor in São Paulo. There he engaged in stimulating discussions with another visitor, André Weil. Two years after his return from Brazil, Zariski became the first tenured Jewish mathematician on the Harvard faculty. By attracting strong students and bringing in distinguished visitors, he soon made Harvard into an international center for algebraic geometry. In the late 1950s the Zariski milieu included his students Heisuke Hironaka, Michael Artin, and David Mumford, as well as the groundbreaking Europeans Jean-Pierre Serre and Alexander Grothendieck.

The biographies in *A History in Sum* illustrate contrasting approaches to doing mathematics. Whereas Zariski thrived on interaction with other great scholars, Hassler Whitney preferred "solitude". According to Nadis and Yau, Saunders Mac Lane's most important contributions came out of his long-term collaboration with Samuel Eilenberg. Andrew Gleason never wrote a paper with his Harvard colleague George Mackey, but found inspiration from their frequent discussions.

Interspersed throughout the twenty-one-page section on Zariski is a variety of mathematical excursions, beginning with the basic idea of algebraic geometry. The authors discuss the motivation behind Zariski's development of algebraic tools as well as provide an introduction to problems over finite fields. I liked the explanation of resolution of singularities, taken largely from an interview of Hironaka in the October 2005 *Notices*.

Nadis and Yau draw heavily from Carol Parikh's biography *The Unreal Life of Oscar Zariski*. Their narrative is enhanced by fresh recollections of mathematicians from Zariski's circle. Over sixty interviews were conducted for the book, including Tate, the only featured subject who survives. The remembrances about Raoul Bott give the reader a genuine feeling of Bott's jovial charm. On the other hand, the section on Marston Morse only hints at the magnitude of his ego.

The authors turned up a variety of biographical sources on their subjects. A minor criticism is that, in some cases, they could have used more discretion in filtering biased perspectives. For example, Garrett Birkhoff should not shape the impression of his father. The dogmatic Norbert Wiener is a less-than-objective source on Harvard faculty. Memorial tributes have a tendency to airbrush personal qualities.

Nevertheless, the featured subjects stand on the merits of their theorems. Tying them together

is their link to Harvard. The strength of the Harvard mathematics department, going back to Ahlfors and Birkhoff, is well known. The careers of Benjamin Peirce, W. F. Osgood, and Maxime Bôcher demonstrate that, with the exception of the ten years from Peirce's death (1880) to the appointment of Osgood (1890), the university faculty has included leading mathematicians since 1831. Indeed, Harvard merits consideration with Johns Hopkins and the University of Chicago as the first academic home for mathematical scholarship in the United States.

Although the authors focus on mathematics at Harvard, a connection to the university is not necessary for enjoyment of the book nor is any special knowledge of the areas explored. *A History in Sum* should find an audience among mathematicians from two broad classes: those who enjoy biography and those who would like to gain a nontechnical flavor of major developments in their science.

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Book Review

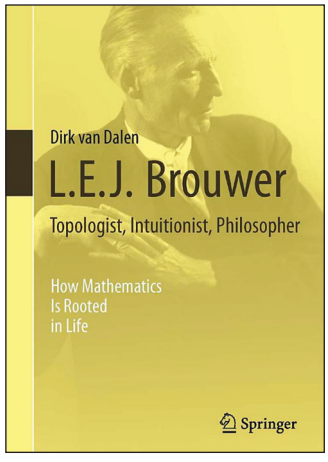
L. E. J. Brouwer—Topologist, Intuitionist, Philosopher: How Mathematics Is Rooted in Life

Reviewed by Dale M. Johnson

L. E. J. Brouwer—Topologist, Intuitionist, Philosopher: How Mathematics Is Rooted in Life
Dirk van Dalen
Springer, 2013
xii + 875 pages
US$44.95 (eBook, US$29.95)
ISBN-13: 978-1-4471-4615-5

L. E. J. Brouwer (1881–1966) is well known to mathematicians primarily as a topologist, one of the two masters who around the beginning of the twentieth century shaped much of later topology; the other is Henri Poincaré (1854–1912). Every mathematician knows the Brouwer fixed point theorem, and most likely know a few other facts about him: that he was the first to prove the topological invariance of dimension and of domain; that he developed further the degree of a mapping as a topological tool; and that he offered a beautiful proof of the Jordan Curve Theorem and stated and proved its generalization, the Jordan-Brouwer Separation Theorem.

Brouwer is better known among mathematical logicians as a founder of a special brand of constructivist thinking in mathematics known as intuitionism. Philosophers may know the philosophical aspects of his mathematical foundational thinking associated with intuitionism. Hence, the subtitle of the book under review, *Topologist, Intuitionist, Philosopher,* is very apt. However, in terms of the *development* of Brouwer's intellectual life as revealed in this full-length biographical study, the order should probably be reversed: philosopher (and mystic to an extent), intuitionist, topologist.



Dirk van Dalen's book is a massive 875 pages; yet it is a revised and somewhat shortened version of his two-volume version published by Oxford University Press [10](xv + x + 946 pp.). Fortunately, the new version, though very large, is very reasonably priced. Van Dalen also published a collection of Brouwer's letters, *The Selected Correspondence of L. E. J. Brouwer* [11], which additionally offers a huge amount of archival material online (3,000+ pages) if one purchases the book. The Brouwer *Collected Works* was published in two volumes: one largely on intuitionism (1975) [2] and the other on mathematics and topology (1976) [3]. Thus in several extensive publications we have a very full picture of a great mathematician and seminal modern thinker.

Van Dalen's excellent biography is a very detailed examination of Brouwer's life; his connections with many other people, including the most famous mathematicians of his time; and his intellectual development and activity from his

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earliest years to his final days. Brouwer himself was a "saver"—he knew that he had created some important work and sought to preserve it. He saved almost every paper and letter he ever touched, and not just mathematical papers and technical notes. He had the good fortune of an unusual companion, Cor Jongejan, as well as his wife, Lize, to look after his letters and intellectual property. Some fires in his archive may have destroyed certain material, but much has been preserved. Van Dalen, I believe, has studied virtually every piece of material related to Brouwer and all the extant letters to put together his very detailed biography. He took on a massive task to chronicle the life of a giant intellect.

Luitzen Egbertus Jan (Bertus, as he was called) Brouwer was born on February 27, 1881, in Overschie, The Netherlands. At the early age of sixteen Bertus enrolled in the University of Amsterdam (also called the Municipal University). It was the academic institution with which he was associated and at which he taught and did research for the rest of his life, though he had several offers at various times to become a professor elsewhere.

As revealed in the first chapters of the book, Brouwer had an early interest in philosophy and a kind of romantic mysticism. His first book, which was published in 1905, is entitled *Leven, Kunst en Mystiek* (*Life, Art, and Mysticism*) [1]. His philosophy tended toward solipsism, and many aspects of his character tended toward the introspective and the interior life. However, in many other ways he was outgoing. Brouwer had many friendships with important mathematicians and other intellectuals. In his youth Brouwer had a close friendship with Adama van Scheltiema (1877–1924), who was a poet and more concerned with the artistic side of life. Throughout his life Brouwer maintained an interest in philosophy and certain philosophical movements, such as the Signific Circle (Signifische Kring), a group of Dutch thinkers interested in philosophy of language and social issues, of which Brouwer was a founding member.

Brouwer's doctoral dissertation represents a highly significant stage in his intellectual development. The dissertation, "Over de grondslagen der wiskunde" (On the foundations of mathematics), completed and defended in 1907, covers several topics, such as the foundational issues of set theory and logic, intuitionism, and mathematical domains, as well as philosophy (in [2], pp. 11–104). Brouwer's thesis advisor was D. J. Korteweg (1848–1941). Korteweg mentored the independent-minded Brouwer and had a significant impact on the thesis. He had Brouwer remove some of the more philosophical parts (see van Stigt [13]). Korteweg was highly influential in Brouwer's career. He campaigned for Brouwer's appointment at Amsterdam and later proposed a plan to enable Brouwer to obtain a full (ordinarius) professorship at Amsterdam. In effect, Korteweg exchanged his ordinary professorship with Brouwer's extraordinary professorship. Korteweg was very discerning in his judgment of Brouwer's mathematical talents. At that time (as now) it was difficult to obtain a good academic position. Many young mathematicians taught in high schools before becoming university lecturers and professors. Brouwer did not take that route.

Brouwer thought of the primary activity of mathematics as an internal mental construction of mathematical objects. The presentation of mathematics in language was very much secondary; logic (one might say) was a distant third. In the dissertation of 1907, as a critique of Hilbert's early work on the foundations of mathematics, Brouwer distinguished eight levels of mathematical treatment, the first three of which are ([2], pp. 94–95) (as translated in the current volume under review, pp. 106–7):

1. The pure construction of intuitive mathematical systems, which, if applied, we externalize by viewing the world mathematically.
2. The language parallel of mathematics: mathematical speaking or writing.
3. The mathematical consideration of the language: logical language construction….

There is a meta-level on top of a meta-level in the eight levels, so to speak.

In his earliest mathematical work Brouwer took up problems such as developing Lie group theory independent of analytical machinery (Hilbert's Fifth Problem in the celebrated list of challenging problems of 1900) and Cantor-style point-set theoretic topology. He studied closely the work of Arthur Schoenflies (1853–1928) in point-set topology and found the work defective; hence, he wrote a highly important critique, "Zur Analysis Situs" (published in 1910) ([3], pp. 352–370), filled with counterexamples to Schoenflies's results. In that paper Brouwer introduced indecomposable continua. At first he and Schoenflies argued about the results, but subsequently they also became lifelong friends. In the mathematical realm Schoenflies was no match for Brouwer, whose incisive topological thinking yielded refutations of many of Schoenflies's results.

On the eve of his greatest discoveries and results in topology, Brouwer presented on October 12, 1909, his inaugural address as a new *privaat docent* at the university, "Het wezen der meetkunde" (The essence of geometry) ([2], pp. 112–120). In this short talk he enumerated some of the hard problems of topology, many of which he went on to solve by proving new theorems. I think that it is important to see Brouwer as a problem solver in mathematics, not as a formal

developer of mathematics. He went after the difficult problems and in many cases solved them. He was not interested so much in the cleanup afterwards into neat theories. He was rigorous but not encyclopedic.

Van Dalen does a very able job of telling the story of Brouwer's topological development in chapters 4 and 5. Brouwer published a veritable flood of fundamental topological results in the years 1909–1913. The First World War, 1914–1918, was a break point in his mathematical career.

From the beginning of his career Brouwer interacted with the greatest mathematicians at conferences, in letters, and in other encounters. David Hilbert (1862–1943) noticed his work very early on, and as a result they corresponded. Other mathematicians with whom he became acquainted early in his career included Jacques Hadamard (1865–1963), Henri Lebesgue (1875–1941), Henri Poincaré, Paul Koebe (1882–1945), Otto Blumenthal (1876–1944), Hermann Weyl (1885–1955), and many others. With some of these mathematicians he had vigorous disputes both on mathematical and on cultural and political grounds. By analyzing the many related letters and other documents, van Dalen carefully lays out these disputes in great detail. Some disputes relate to the aftermath of the First World War, when German mathematicians were largely excluded from the international community because of the widely held perception that the Germans were the main cause and offenders in the war.

Brouwer's intuitionism is famous or perhaps infamous. His rejection of the universal validity of the law of excluded middle is startling to many mathematicians, since it fundamentally calls into question many important proofs in mathematics. His constructivism does not permit commonly accepted existence proofs. Even Brouwer's own proofs in topology do not remain valid under these strictures. He recognized that fact and in the 1920s sought to modify some of his earlier proofs to make them intuitionistically acceptable.

In the years just after the First World War, Brouwer found an ally in intuitionism, Hermann Weyl, who developed his own approach to foundations and then strongly supported Brouwer's foundational position: "… and Brouwer—that is the revolution." In developing his own foundational and constructivist thinking, Weyl wrote his classic monograph *Das Kontinuum* (The Continuum) (1918) [15], as well as other papers (in [16]).

Brouwer's brand of intuitionistic mathematics developed over the years. There are several formulations. Van Dalen does an excellent job in telling this story of mathematical development, including also the human interactions (contentious at times) with other mathematicians (on constructivism see also [9], [12]). Brouwer's introduction of choice sequences in his constructivism was an important step.

In the 1920s the most celebrated dispute was between Brouwer and Hilbert over foundations of mathematics: Brouwer's intuitionist program versus Hilbert's formalism and metamathematical program. Some papers of the era, especially those by Hilbert, are highly polemical. A strange outcome of the dispute was the elimination of Brouwer from the editorial board of *Mathematische Annalen*, a premier journal of the day. Brouwer worked hard as an editor to bring papers for publication to the highest standard, and he did not impose his intuitionism on them. Yet Hilbert saw fit to have him removed. The reasons are not entirely clear. The story is complicated, so one needs to read carefully the analysis that van Dalen provides. His analysis seems deeper than that of Constance Reid [8], given all the documents that are now available.

Another highly significant dispute was over priority in dimension theory, not just proving the topological invariance of dimension. The dispute was complicated by the fact that Brouwer made a "slip of the pen" (*Schreibfehler*) in his great paper on the definition of dimension. Brouwer interacted with Paul (Pavel) Urysohn (1898–1924) on the matter, and they came to agree on a common position. However, Brouwer ended up with a considerable difference of opinion on priority with the then very young and new mathematician Karl Menger (1902–1985). Van Dalen relates the details in the volume under review (pp. 595–601); in the earlier version of his biography he gives greater space to this unpleasant dispute ([10], pp. 643–671).

Brouwer often was deeply involved with academic matters and pure politics at Amsterdam. One can see the pettiness of some of these things in van Dalen's careful treatment of them. No doubt such things still happen in academia.

Brouwer was often a loner. He conducted his life and research mostly at his hut (house) in Blaricum, outside Amsterdam. Many mathematicians went there to discuss mathematics, and the discussions were very fruitful. He seems to have had a condescending view of the world at times. One can imagine that he was just plain difficult to deal with on many issues. He preferred being right to being forgiving.

Regardless of his personality one cannot deny Brouwer's great achievements in topology, in intuitionism, and in foundational thinking. He was truly a giant of twentieth-century mathematics. Van Dalen really does a great service to the memory of such an intellect. The reader may become overwhelmed by all the details that van Dalen covers, but one is free to be selective in reading parts of the book according to one's interests.

By surveying recent general interest mathematical literature, one realizes that several full-length biographies have been written about important

About the cover

From L. E. J. Brouwer's "Zur Analysis Situs"

The cover image was suggested by the review in this issue of a biography of the Dutch mathematician L. E. J. Brouwer. The original diagram was one of two inserted as separate sheets into Brouwer's article "Zur Analysis Situs" in the 1910 volume of the *Mathematischen Annalen*. As far as we can tell, it was the first colored diagram to be published in any mathematical research journal, and is apparently the only colored diagram ever to have been published in the *Annalen*.

Brouwer is probably best known for his strong stance on constructive proofs, but of course he is also well known for his theorem on fixed-points. He was in fact one of the founders of modern topology. "Zur Analysis Situs" was his response to some prior work of the mathematician Schoenflies, who was at that time considered the world expert on the topology of point sets in the plane. But Brouwer had found Schoenflies's work to contain serious errors. Basically, what he pointed out was that Schoenflies had not been rigorous enough, and that the topological structure of point sets in the plane was often far from intuitive.

The figure on the cover served in his paper to illustrate several of his objections. It exhibited among other things Brouwer's construction of the first known *indecomposable continuum*—that is to say, a compact, connected subset of the plane that could not be expressed as the union of two proper closed connected subsets. This set is constructed as the intersection of a sequence of annuli. Each one is obtained from the previous one by removing two disjoint sets from the previous one. In the cover image, the construction is at the third stage. The annulus is the light region, the interior of the annulus is the region hatched in red, and its exterior is hatched in black. On the cover, Brouwer's diagram has been extended to include a larger background area hatched in black.

We find, as Schoenflies also found, Brouwer's explanation of his figure a bit hard to follow. His results were soon incorporated into the literature of topology, but rather different and simpler diagrams replaced his. The clearest explanation of Brouwer's diagram itself that we have found is the survey "A brief historical view of continuum theory" in the 2006 volume of *Topology and its Applications*, by W. T. Ingram. He interprets the intersection of the sequence of annuli as an

(Continued on page 676)

mathematicians of the late nineteenth and early twentieth centuries, including ones for Georg Cantor [4]; Henri Poincaré [7], [14]; David Hilbert [8]; Ernst Zermelo [5]; and Constantin Carathéodory [6]. Van Dalen's biography is certainly one of the most extensive. The author must have spent countless hours collecting and analyzing the many extant documents related to the famous Dutchman. In this book we have a detailed and valuable picture of a great mathematician.

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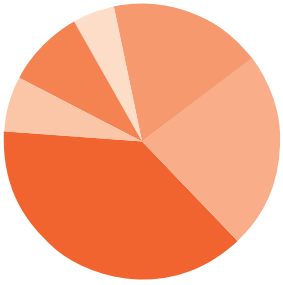


2013-2014 Faculty Salaries Report

William Yslas Vélez, James W. Maxwell, and Colleen Rose

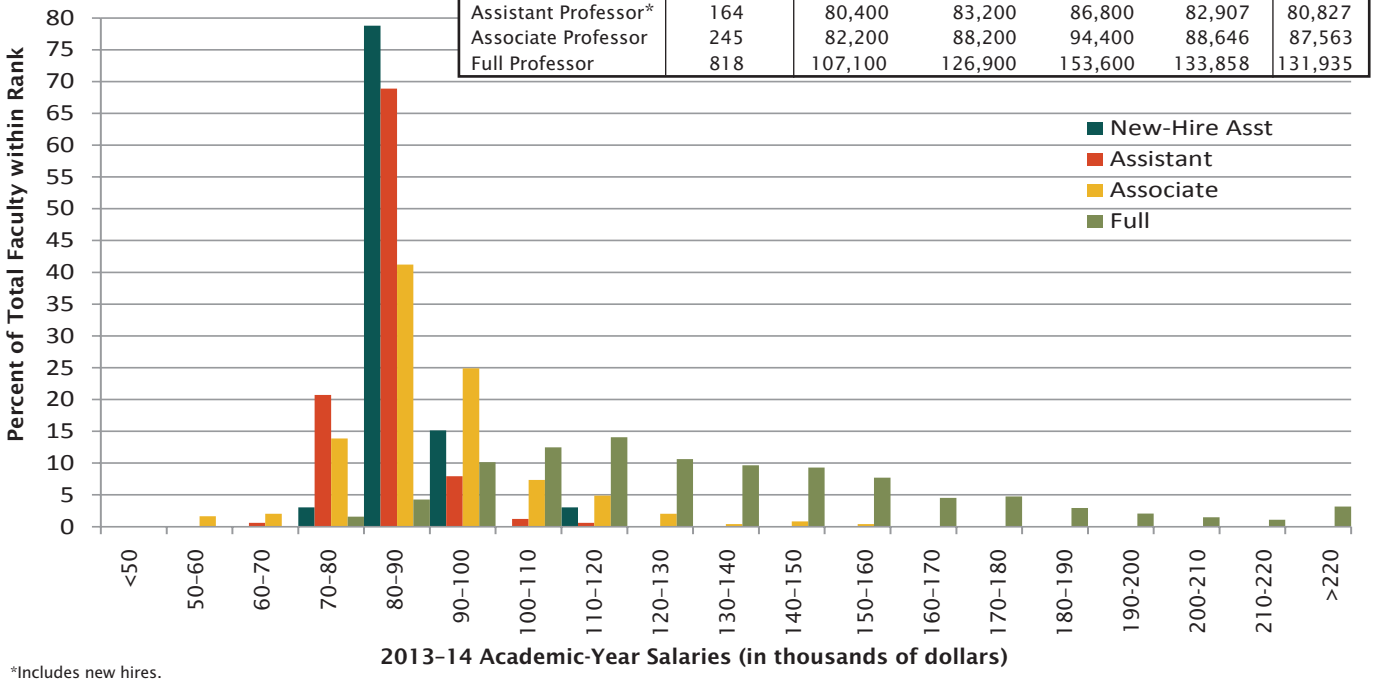
This report provides information on the distribution of 2013–2014 academic-year salaries for tenured and tenure-track faculty at four-year mathematical sciences departments in the U.S. by the departmental groupings used in the Annual Survey. (See page 6 for the definitions of the various departmental groupings.) Salaries are described separately by rank. Salaries are reported in current dollars (at time of data collection). Results reported here are based on the departments which responded to the survey with no adjustment for non-response.

Departments were asked to report for each rank the number of tenured and tenure-track faculty whose 2013–2014 academic-year salaries fell within given salary intervals. Reporting salary data in this fashion ensures confidentiality of individual reponses, though it does mean that the reported quartiles are only approximations. The quartiles reported have been estimated assuming that the density over each interval is uniform.

When comparing current and prior year figures, one should keep in mind that differences in the set of responding departments may be one of the most important factors in the change in the reported mean salaries. This report uses the new groupings of doctoral-granting mathematics departments recently adopted by the Joint Data Committee. Additional detail is provided on page 616.

Math. Public Large Group Faculty Salaries
Doctoral degree-granting departments of mathematics
25 responses out of 26 departments (96%)

Rank	2013–14					2012–13
	No. Reported	Q_1	Median	Q_3	Mean	Mean
New-Hire Asst Prof	33	82,200	84,700	88,900	85,322	83,242
Assistant Professor*	164	80,400	83,200	86,800	82,907	80,827
Associate Professor	245	82,200	88,200	94,400	88,646	87,563
Full Professor	818	107,100	126,900	153,600	133,858	131,935



*Includes new hires.

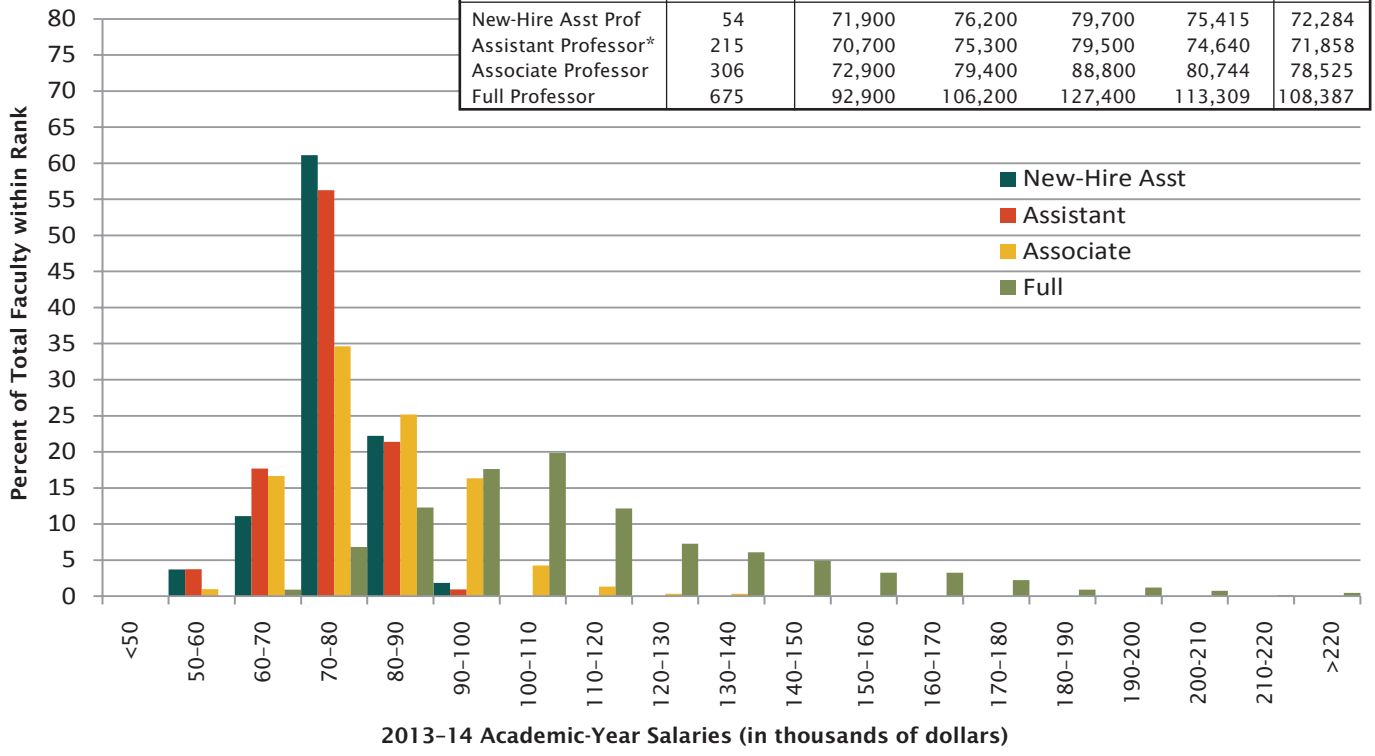
William Yslas Vélez is a professor in the Department of Mathematics at University of Arizona. James W. Maxwell is AMS Coordinator of special projects. Colleen A. Rose is AMS survey analyst.

Math. Public Medium Group Faculty Salaries

Doctoral degree-granting departments of mathematics

36 responses out of 40 departments (90%)

Rank	2013–14 No. Reported	Q_1	Median	Q_3	Mean	2012–13 Mean
New-Hire Asst Prof	54	71,900	76,200	79,700	75,415	72,284
Assistant Professor*	215	70,700	75,300	79,500	74,640	71,858
Associate Professor	306	72,900	79,400	88,800	80,744	78,525
Full Professor	675	92,900	106,200	127,400	113,309	108,387

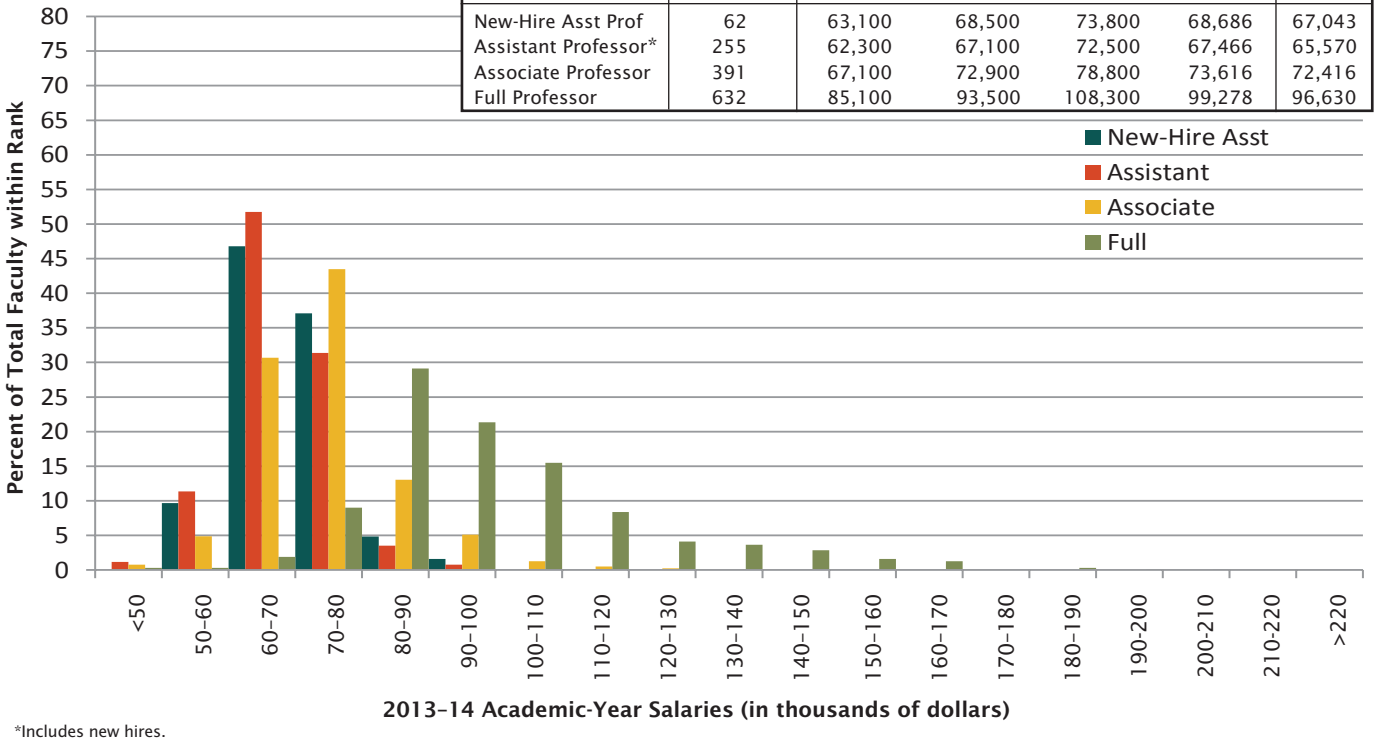


Math. Public Small Group Faculty Salaries

Doctoral degree-granting departments of mathematics

53 responses out of 64 departments (83%)

Rank	2013–14 No. Reported	Q_1	Median	Q_3	Mean	2012–13 Mean
New-Hire Asst Prof	62	63,100	68,500	73,800	68,686	67,043
Assistant Professor*	255	62,300	67,100	72,500	67,466	65,570
Associate Professor	391	67,100	72,900	78,800	73,616	72,416
Full Professor	632	85,100	93,500	108,300	99,278	96,630



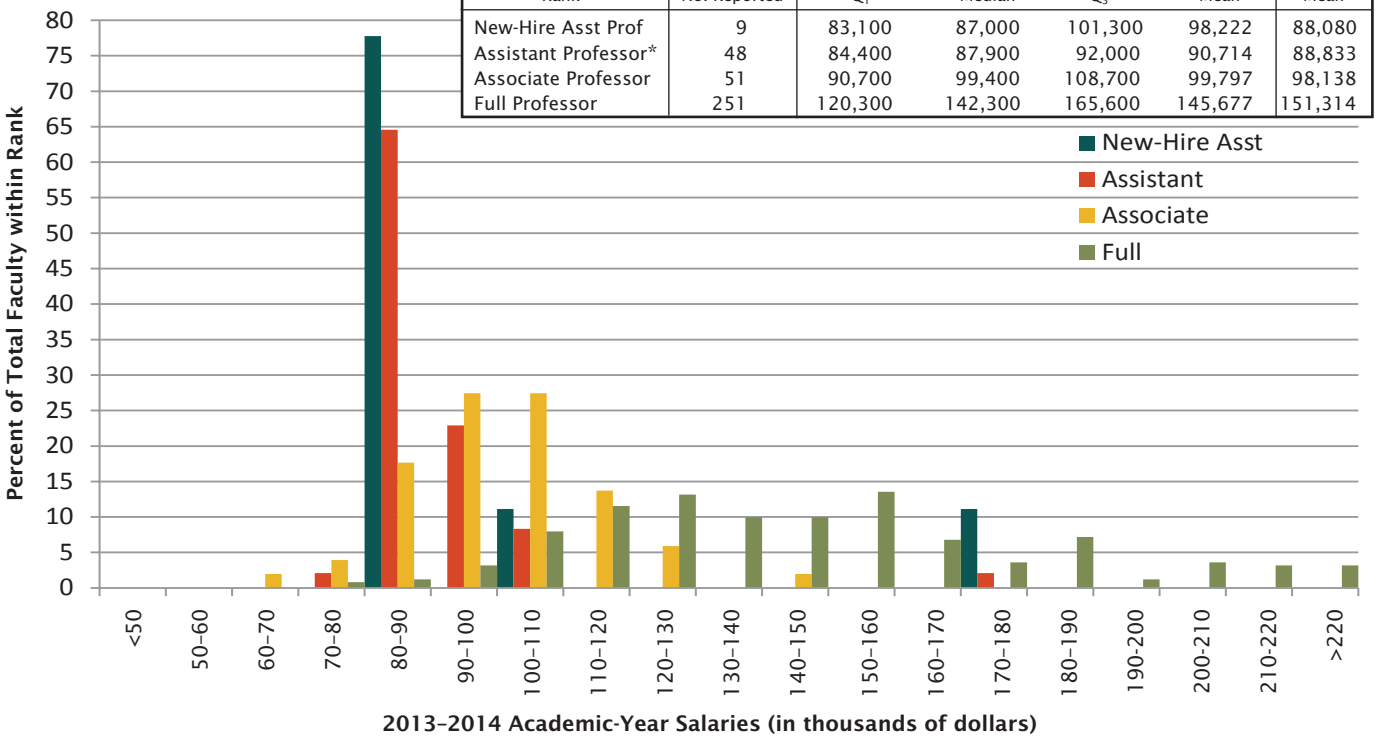
*Includes new hires.

Math. Private Large Group Faculty Salaries

Doctoral degree-granting departments of mathematics

15 responses out of 24 departments (63%)

Rank	2013–14 No. Reported	Q_1	Median	Q_3	Mean	2012–13 Mean
New-Hire Asst Prof	9	83,100	87,000	101,300	98,222	88,080
Assistant Professor*	48	84,400	87,900	92,000	90,714	88,833
Associate Professor	51	90,700	99,400	108,700	99,797	98,138
Full Professor	251	120,300	142,300	165,600	145,677	151,314

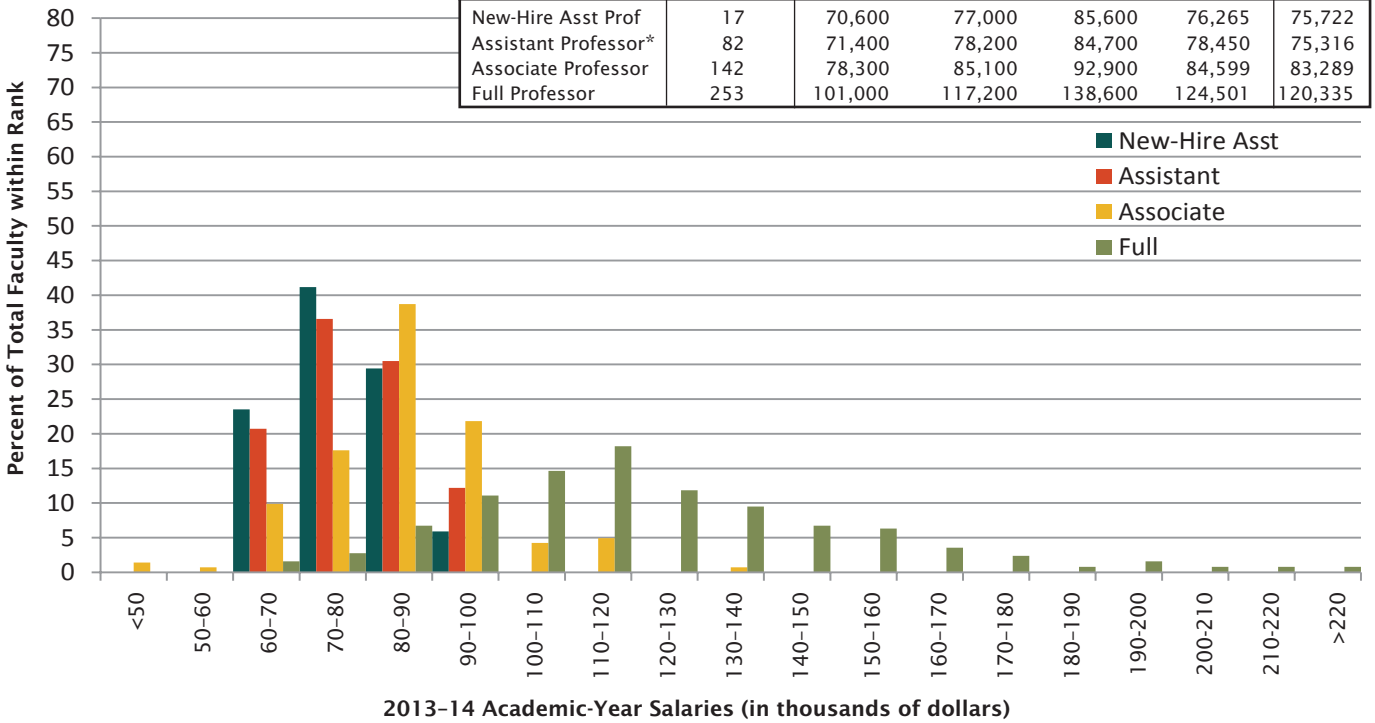


Math. Private Small Group Faculty Salaries

Doctoral degree-granting departments of mathematics

24 responses out of 28 departments (86%)

Rank	2013–14 No. Reported	Q_1	Median	Q_3	Mean	2012–13 Mean
New-Hire Asst Prof	17	70,600	77,000	85,600	76,265	75,722
Assistant Professor*	82	71,400	78,200	84,700	78,450	75,316
Associate Professor	142	78,300	85,100	92,900	84,599	83,289
Full Professor	253	101,000	117,200	138,600	124,501	120,335



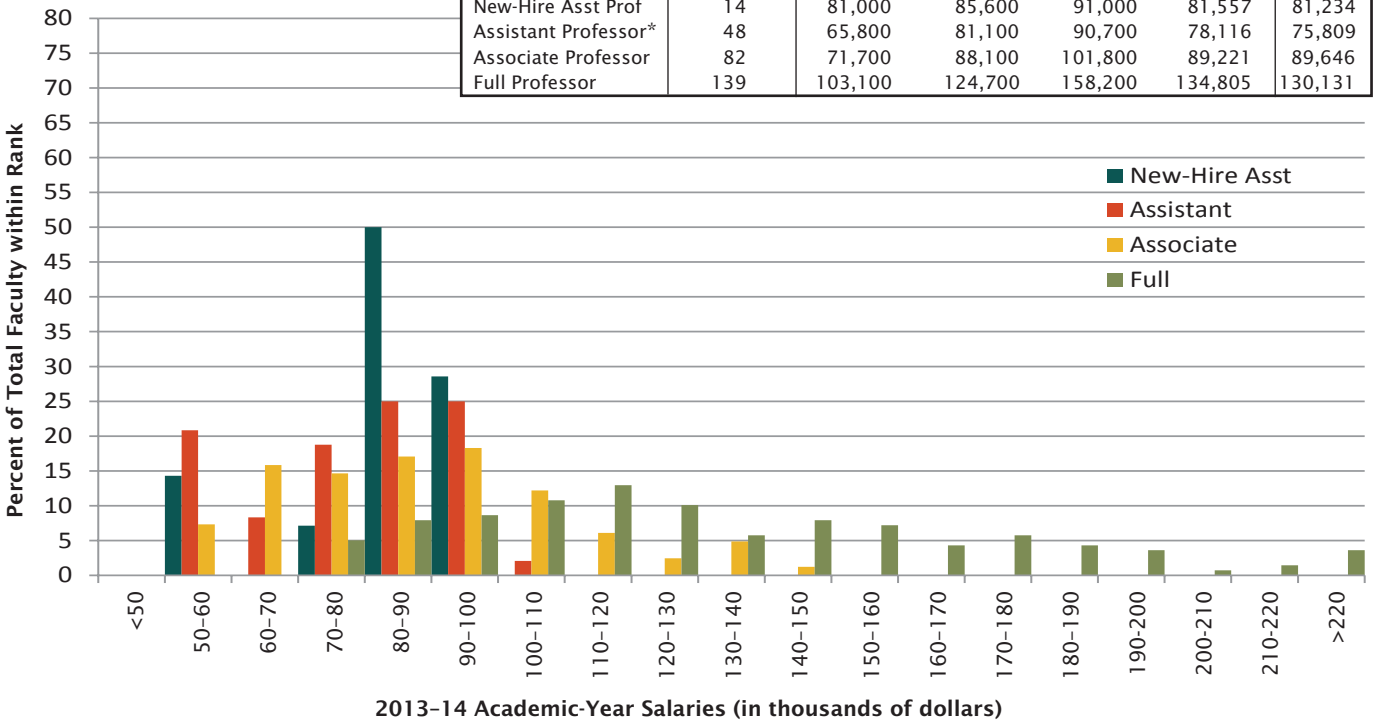
*Includes new hires.

Applied Mathematics Group Faculty Salaries

Doctoral degree-granting departments of Applied Mathematics

16 responses out of 24 departments (67%)

Rank	2013–14 No. Reported	Q_1	Median	Q_3	Mean	2012–13 Mean
New-Hire Asst Prof	14	81,000	85,600	91,000	81,557	81,234
Assistant Professor*	48	65,800	81,100	90,700	78,116	75,809
Associate Professor	82	71,700	88,100	101,800	89,221	89,646
Full Professor	139	103,100	124,700	158,200	134,805	130,131

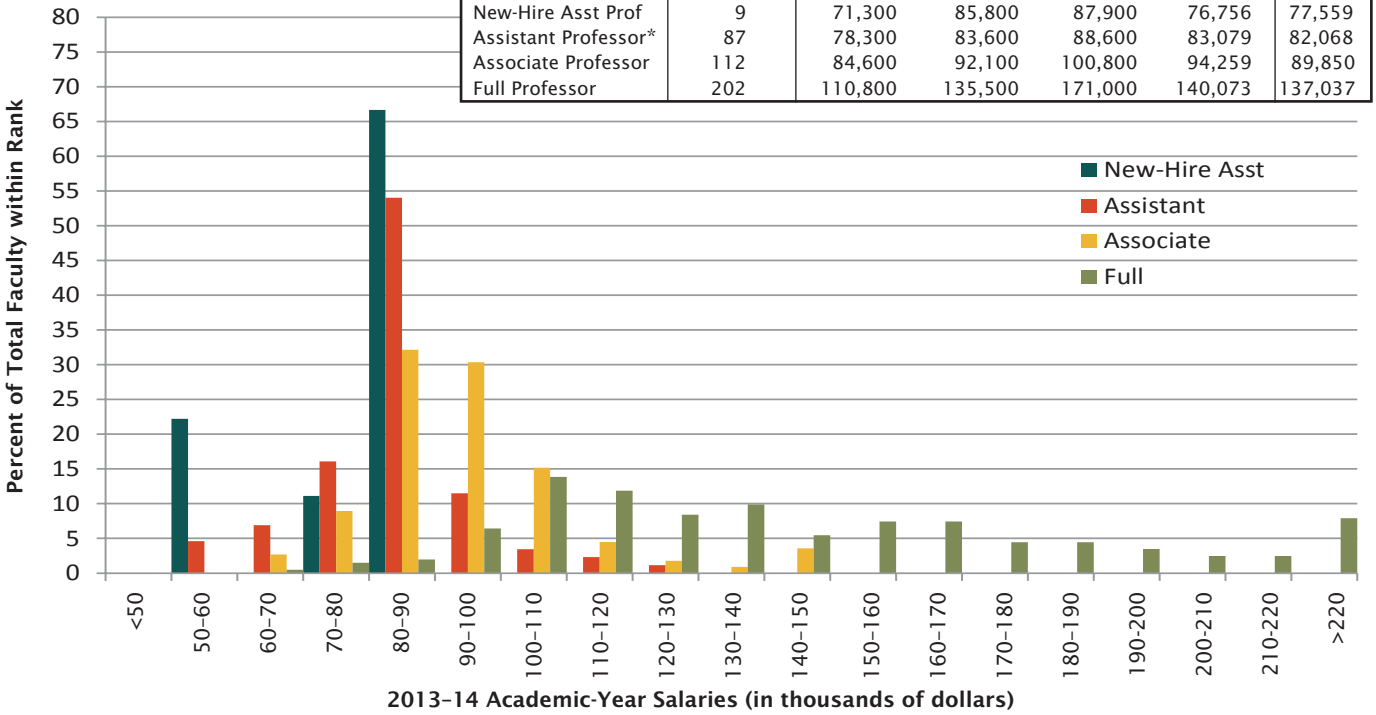


Statistics Group Faculty Salaries**

Doctoral degree-granting departments of statistics

34 responses out of 58 departments (59%)

Rank	2013–14 No. Reported	Q_1	Median	Q_3	Mean	2012–13 Mean
New-Hire Asst Prof	9	71,300	85,800	87,900	76,756	77,559
Assistant Professor*	87	78,300	83,600	88,600	83,079	82,068
Associate Professor	112	84,600	92,100	100,800	94,259	89,850
Full Professor	202	110,800	135,500	171,000	140,073	137,037



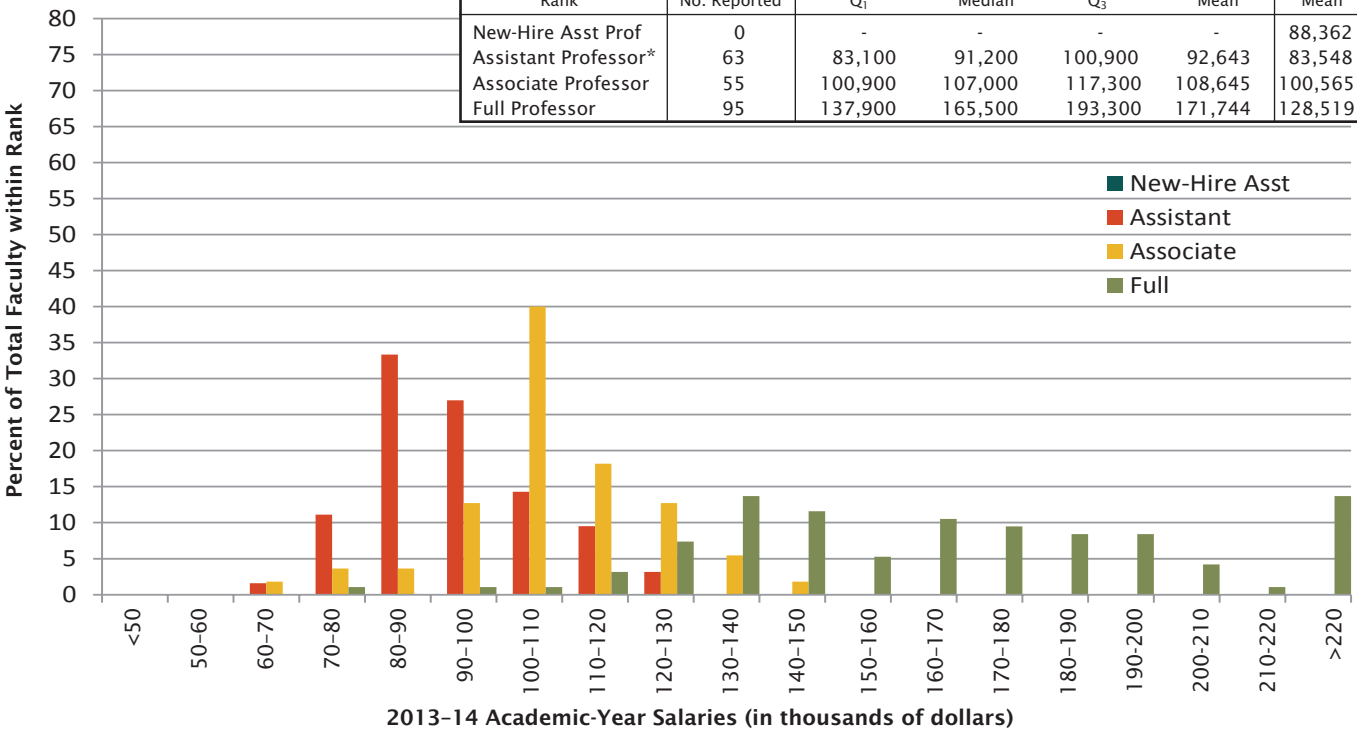
*Includes new hires.
**Faculty salary data provided by the American Statistical Association.

Biostatistics Group Faculty Salaries**

Doctoral degree-granting departments of biostatistics

13 responses out of 43 departments (30%)

Rank	2013–14 No. Reported	Q_1	Median	Q_3	Mean	2012–13 Mean
New-Hire Asst Prof	0	-	-	-	-	88,362
Assistant Professor*	63	83,100	91,200	100,900	92,643	83,548
Associate Professor	55	100,900	107,000	117,300	108,645	100,565
Full Professor	95	137,900	165,500	193,300	171,744	128,519

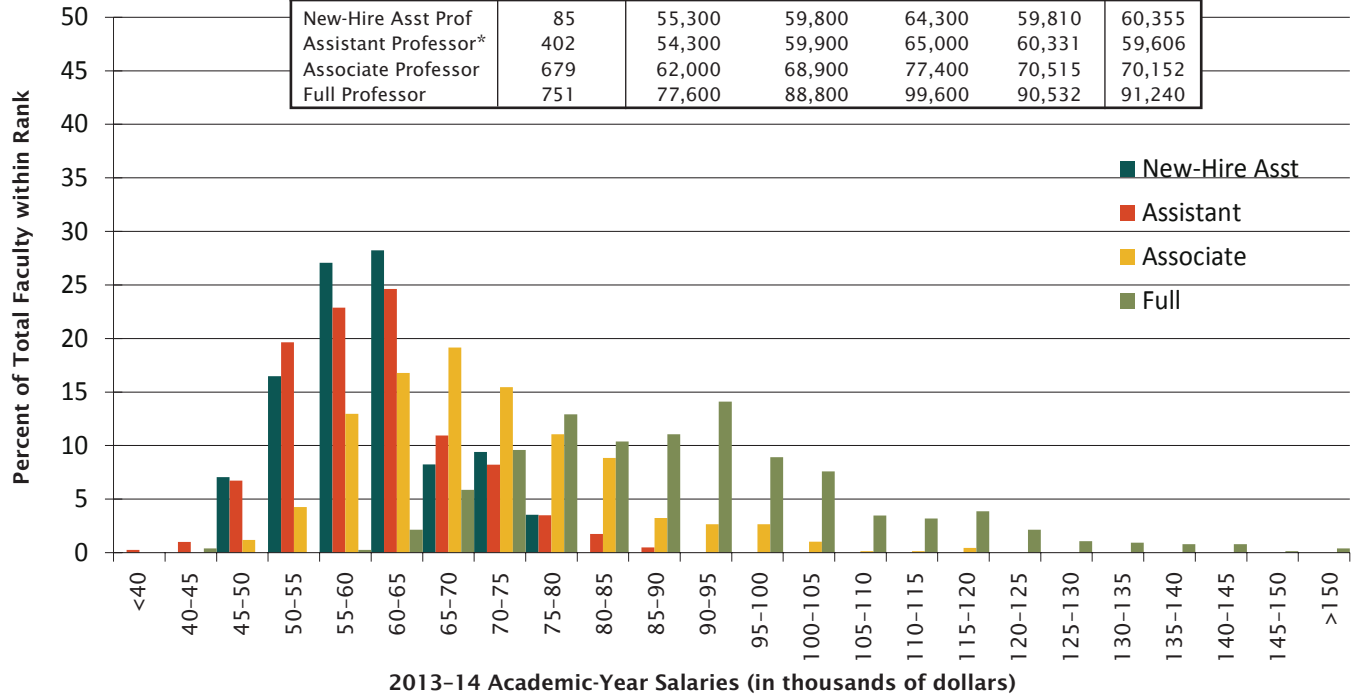


Master's Group Faculty Salaries

Master's degree-granting departments of mathematics

96 responses out of 182 departments (53%)

Rank	2013–14 No. Reported	Q_1	Median	Q_3	Mean	2012–13 Mean
New-Hire Asst Prof	85	55,300	59,800	64,300	59,810	60,355
Assistant Professor*	402	54,300	59,900	65,000	60,331	59,606
Associate Professor	679	62,000	68,900	77,400	70,515	70,152
Full Professor	751	77,600	88,800	99,600	90,532	91,240



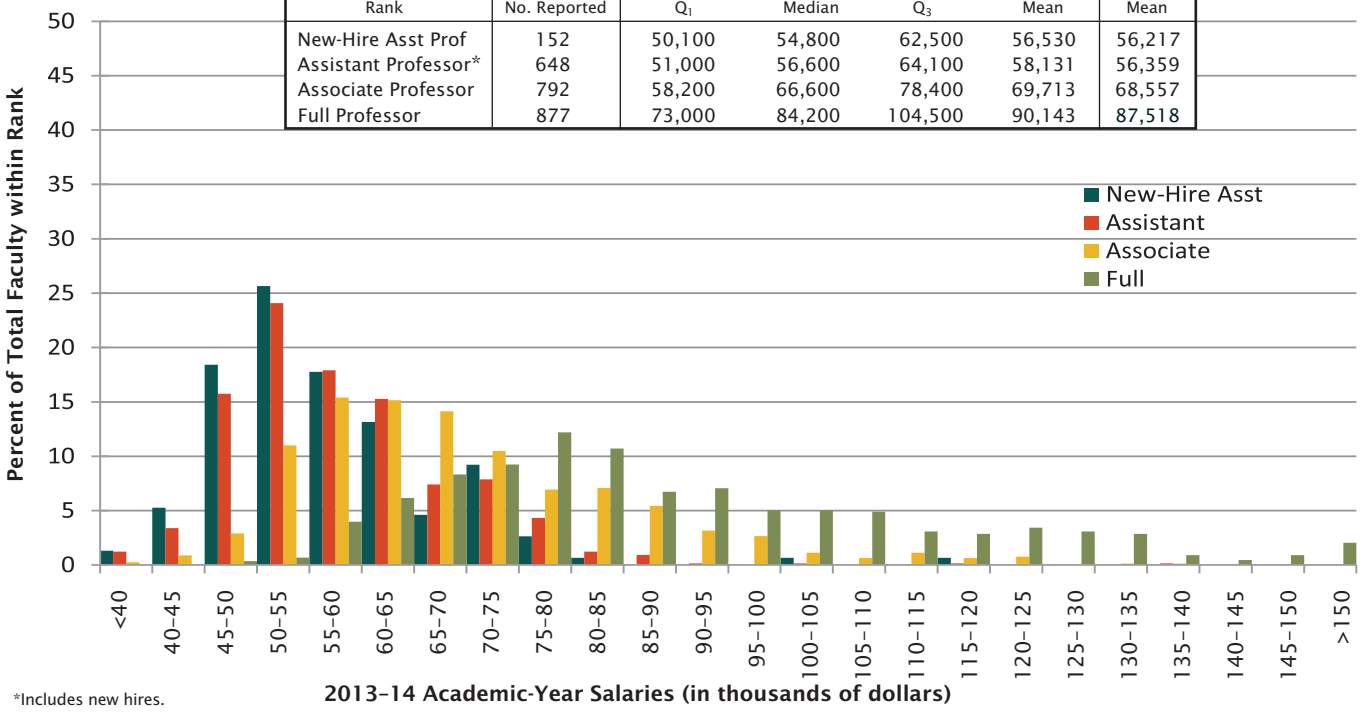
*Includes new hires.
**Faculty salary data provided by the American Statistical Association.

Bachelor's Group Faculty Salaries

Bachelor's degree-granting departments of mathematics

278 responses out of 1,002 departments (28%)

Rank	2013–14 No. Reported	Q_1	Median	Q_3	Mean	2012–13 Mean
New-Hire Asst Prof	152	50,100	54,800	62,500	56,530	56,217
Assistant Professor*	648	51,000	56,600	64,100	58,131	56,359
Associate Professor	792	58,200	66,600	78,400	69,713	68,557
Full Professor	877	73,000	84,200	104,500	90,143	87,518



*Includes new hires.

Departmental Groupings

Starting with reports on the 2012 AMS-ASA-IMS-MAA-SIAM Annual Survey of the Mathematical Sciences, the Joint Data Committee has implemented a new method for grouping the doctorate-granting mathematics departments. These departments are first grouped into those at public institutions and those at private institutions. These groups are further subdivided based on the size of their doctoral program as reflected in the average annual number of Ph.D.'s awarded between 2000 and 2010, based on their reports to the Annual Survey during this period. Furthermore, doctorate-granting departments which self-classify their Ph.D. program as being in applied mathematics will join with the other applied mathematics departments previously in Group Va to form their own group. The former Group IV will be divided into two groups, one for departments in statistics and one for departments in biostatistics.

For further details on the change in the doctoral department groupings see the article in the October 2012 issue of *Notices of the AMS* at `http:www.ams.org/notices/201209/rtx120901262p.pdf`.

Math. Public Large consists of departments with the highest annual rate of production of Ph.D.'s, with at least 7.0 per year.
Math. Public Medium consists of departments with an annual rate of production of Ph.D.'s, ranging between 3.9 and 6.9 per year.
Math. Public Small consists of departments with an annual rate of production of Ph.D.'s, with 3.8 per year or fewer.
Math. Private Large consists of departments with an annual rate of production of Ph.D.'s, with at least 3.9 per year.
Math. Private Small consists of departments with an annual rate of production of Ph.D.'s, with 3.8 per year or fewer.
Applied Mathematics consists of doctoral-degree-granting applied mathematics departments.
Statistics consists of doctoral-degree-granting statistics departments.
Biostatistics consists of doctoral-degree-granting biostatistics departments.
Group M contains U.S. departments granting a master's degree as the highest graduate degree.
Group B contains U.S. departments granting a bachelor's degree only.

Listings of the actual departments which compose these groups are available on the AMS website at `www.ams.org/annual-survey/groups`.

Obtain a Special Faculty Salaries Analysis

See how the salaries of your department's tenured/tenure-track faculty compare to those in similar departments. The only requirement is that your department must have responded to our latest Faculty Salary survey.

Send a list of your peer institutions (a minimum of 12 institutions is required) to ams-survey@ams.org along with the date the analysis is needed. (If not enough of your peer group have responded to the salary survey you'll be asked to provide additional institutions.) A minimum of two weeks is needed to complete a special analysis.

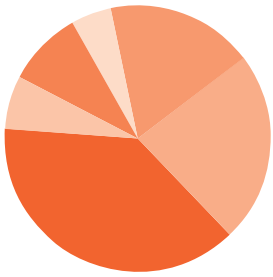
The analysis produced includes a listing of your peer group institutions along with their salary survey response status, a summary table including the rank (assistant, associate, and full professor), the number reported in each rank, the 1st quartile, median, 3rd quartile, and mean salaries for each along with bar graphs.

Acknowledgments

The Annual Survey attempts to provide an accurate appraisal and analysis of various aspects of the academic mathematical sciences scene for the use and benefit of the community and for filling the information needs of the professional organizations. Every year, college and university departments in the United States are invited to respond. The Annual Survey relies heavily on the conscientious efforts of the dedicated staff members of these departments for the quality of its information. On behalf of the Data Committee and the Annual Survey Staff, we thank the many secretarial and administrative staff members in the mathematical sciences departments for their cooperation and assistance in responding to the survey questionnaires.

About the Annual Survey

The Annual Survey series, begun in 1957 by the American Mathematical Society, is currently under the direction of the Data Committee, a joint committee of the American Mathematical Society, the American Statistical Association, the Mathematical Association of America, and the Society of Industrial and Applied Mathematics. The current members of this committee are Richard Cleary, David Cox, Charles Epstein, Sue Geller, Amanda Golbeck, Loek Helminck, Abbe H. Herzig, Ellen Kirkman, James W. Maxwell (ex officio), William Yslas Vélez (chair) and Edward Waymire. The committee is assisted by AMS survey analyst Colleen A. Rose. In addition, the Annual Survey is sponsored by the Institute of Mathematical Statistics. Comments or suggestions regarding this Survey Report may be emailed to the committee at ams-survey@ams.org.



Preliminary Report on the 2012–2013 New Doctoral Recipients

William Yslas Vélez, James W. Maxwell, and Colleen Rose

This report presents a statistical profile of recipients of doctoral degrees awarded by departments in the mathematical sciences at universities in the United States during the period July 1, 2012, through June 30, 2013. The report includes a preliminary analysis of the fall 2013 employment plans of 2012–2013 doctoral recipients and a demographic profile summarizing characteristics of citizenship status and gender. The report on the 2012–2013 New Doctoral Recipients will include subsequent reports of additional 2012–2013 doctoral recipients from the departments that did not respond in time for this report, along with additional information provided by the doctoral recipients themselves. A list of the nonresponding departments is on page 620. This report uses the new groupings of doctoral-granting mathematics departments recently adopted by the Joint Data Committee. Additional detail can be found on the AMS website at `www.ams.org/annual-survey/groups`.

Doctoral Degrees Awarded

The preliminary data shows that 1,712 new Ph.D.'s were awarded by 284 departments that responded in time for this report. These new Ph.D.'s consist of:

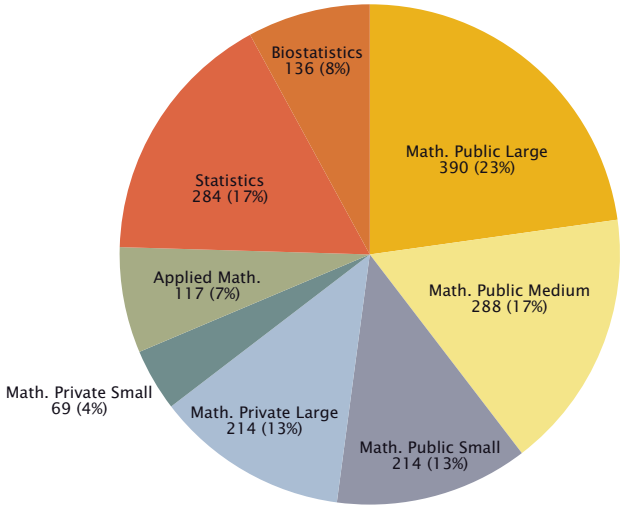
- 1,172 Males
- 540 Females
- 770 U.S. citizens
- 942 Non-U.S. citizens

Based on the data collected so far it is likely that the final count of Ph.D.'s awarded during 2012–2013 will exceed the record total of 1,798 reported for 2011–2012. The departments that have responded in both survey cycles reported 1,708 for 2012-2013 versus 1,672 for 2011–2012, a 2.2% increase.

Preliminary employment data on new Ph.D.'s shows that 9% are unemployed or not seeking and of those whose employment status is known (1,559):

- 79% are U.S. employed
- 14% are Non-U.S. employed
- 49% of those employed in the U.S. are U.S. citizens

Figure P.1: Number and Percentage of Degrees Awarded by Department Grouping*



Total Degrees Awarded: 1,712

*A description of the department groupings can be viewed at ww.ams.org/annual-survey/groups.

William Yslas Vélez is a professor in the Department of Mathematics at University of Arizona. James W. Maxwell is AMS coordinator of special projects. Colleen A. Rose is AMS survey analyst.

Doctoral Degrees Awarded

The graphics below provide a snapshot of the preliminary data on new doctorates by gender, citizenship, employment status, employer type, and field of thesis. Watch for the release of the final report (Summer 2014) to see the full statistical profile along with comparative data on this cohort of new doctoral recipients.

Figure P.2: Gender of Doctoral Recipients by Department Grouping

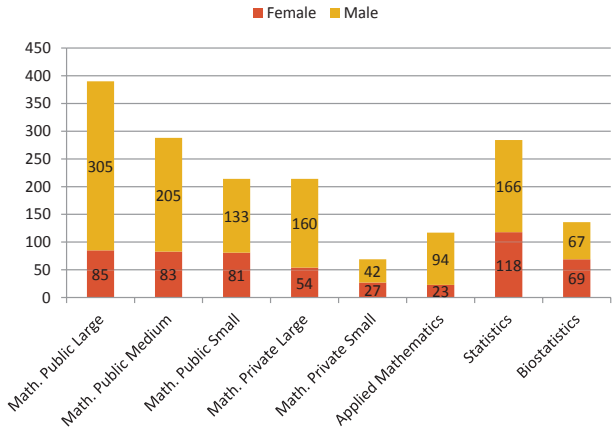


Figure P.3: Citizenship of Doctoral Recipients by Department Grouping

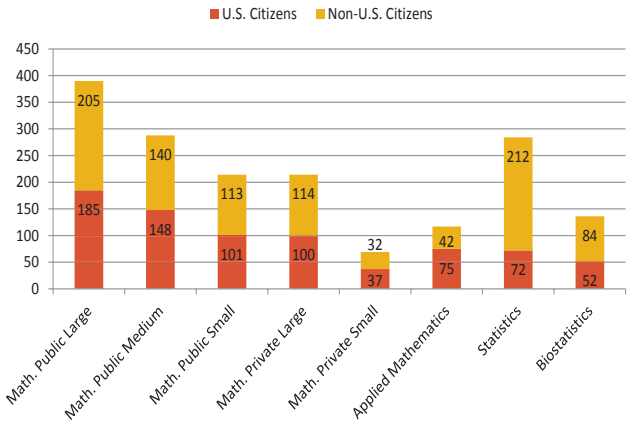
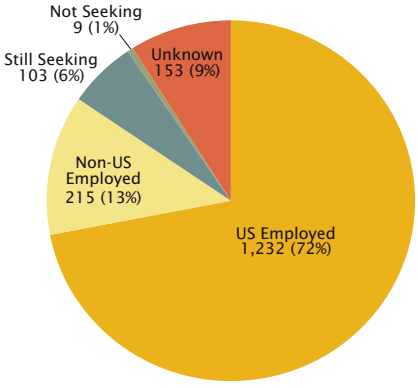
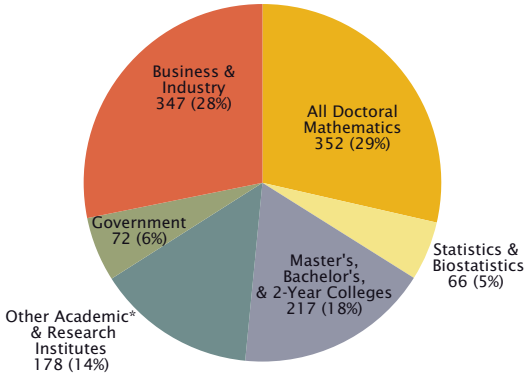


Figure P.4: Employment Status



Total Degrees Awarded: 1,712

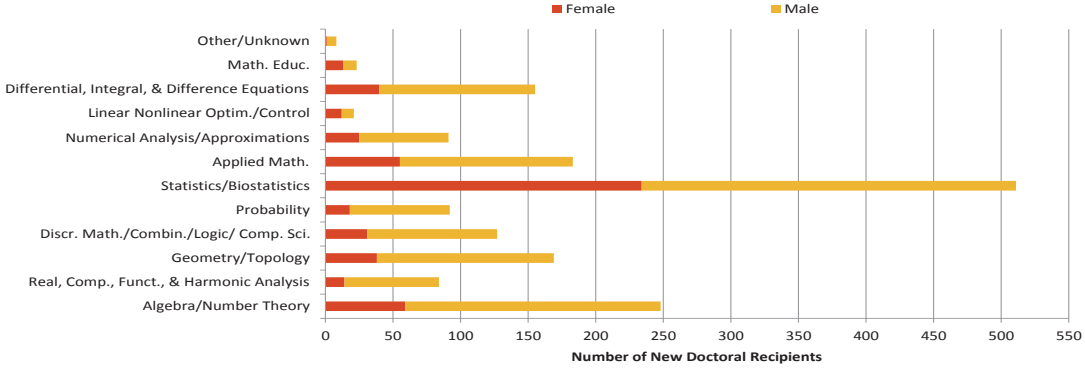
Figure P.5: U.S. Employed by Type of Employer



Total U.S. Employed: 1,232

*Other Academic consists of departments outside the mathematical sciences including numerous medical related units.

Figure P.6: New Doctoral Recipients by Field of Thesis and Gender



Departmental Response Rates

Survey Response Rates by New Groupings

Doctorates Granted
Departmental Response Rates

Math. Public Large	24 of 26 including	0 with no degrees
Math. Public Medium	40 of 40 including	1 with no degrees
Math. Public Small	60 of 64 including	9 with no degrees
Math. Private Large	23 of 24 including	0 with no degrees
Math. Private Small	26 of 28 including	2 with no degrees
Applied Math.	28 of 30 including	3 with no degrees
Statistics	53 of 59 including	3 with no degrees
Biostatistics	30 of 44 including	6 with no degrees
Total	284 of 315 including	24 with no degrees

Doctoral Degrees Not Yet Reported

The following mathematical sciences, applied mathematics, statistics, and biostatistics departments had not responded in time for their data to be included in this report. Those departments listed with an "*" have yet to respond as of March 29, 2014. Every effort will be made to collect the responses from these departments for inclusion in the New Doctoral Recipients Report which will be published in the August 2014 issue of *Notices of the AMS.*

Departments yet to respond can obtain copies of the Doctorates Granted survey forms on the AMS website at `www.ams.org/annual-survey/surveyforms`, by sending email to `ams-survey@ams.org`, or by calling 1-800-321-4267, ext. 4189.

Math. Public Large

University of California, Santa Barbara
University of Illinois at Chicago

Math. Public Medium

All departments responded.

Math. Public Small

Wayne State University
University of Missouri-Kansas City
Utah State University
University of Vermont

Math. Private Large

All departments responded.

Math. Private Small

Howard University
Syracuse University

Applied Mathematics

Columbia University
Stony Brook University

Statistics

University of California, Los Angeles
Colorado State University
Iowa State University*
Harvard University
Oklahoma State University
Baylor University

Biotatistics

Cornell University
LSU Health Science Center, New Orleans
Rutgers School of Public Health*
St. Louis University College for Public Health & Social Justice
The University of Albany, SUNY
Tulane University
University of California, Los Angeles
University of Cincinnati, Medical College
University of Illinois, Chicago
University of Kentucky
University of Louisville
University of Massachusetts, Amherst
University of Oklahoma, Health Science Center
University of South Carolina
University of South Florida
Virginia Commonwealth University

Frazzled Academics: Unite to Improve Teaching!

Sybilla Beckmann and Jacob Hicks

Are you this frazzled academic who cares about education?

> Frazzled academic: "I put the last paper on top of the stack after recording grades on my latest test. Now I only have fifteen minutes to get to yet another faculty meeting…. I get back to my office and take a breath. My mind wanders to the test. The students could have done better. Their algebra is a mess! Did they learn anything in high school? Did they listen to what I said in class? Though honestly, I know I could be a better teacher; I want to be. But that grant application…. How do I find the time to become a better teacher? And even if I had the time, what would I do to improve?"

How do we become better at teaching? Can we do so without devoting all our time and energy to teaching?

Improving mathematics teaching is a big, important project, and big, important projects usually are not done in isolation. They typically take a community and collective thinking over time. Alone, we are unlikely to continuously polish, refine, and develop our teaching. But what if we had others to encourage, inspire, and build us up? What if we could learn with and from other people who care about mathematics teaching? We need the ongoing support of a community to help us develop our skills and ideas about mathematics teaching. The Mathematics Teaching Community (MTC), online at

`https://mathematicsteachingcommunity.math.uga.edu`,

is designed for people who teach mathematics to work together to become better teachers. You can go to the MTC to find out what others are currently thinking. Suppose you are interested in teaching calculus or analysis or in teacher preparation in light of the K–12 Common Core State Standards (CCSS) for Mathematics. Figure 1 shows a few examples of what you will find if you search for "calculus" or "analysis". Figure 2 shows a few submissions under the CCSS tag. You can also browse through the tags. If you cannot find the specific tag, topic, or question for which you are looking, you can post a new submission. If you find something interesting, you can make comments or ask questions.

Your submissions can be about your own classroom practices or about broader issues of mathematics education that affect you. Maybe you are questioning whether we should be teaching related rates in calculus. Others can agree with you or provide a new perspective on why related rates are important. Maybe you have a great idea for teaching optimization problems. Others can read and learn from what you have written. They can ask you questions or bring up ideas you had

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DOI: http://dx.doi.org/10.1090/noti1130

Figure 1. Some submissions under the "calculus" and "analysis" tags.

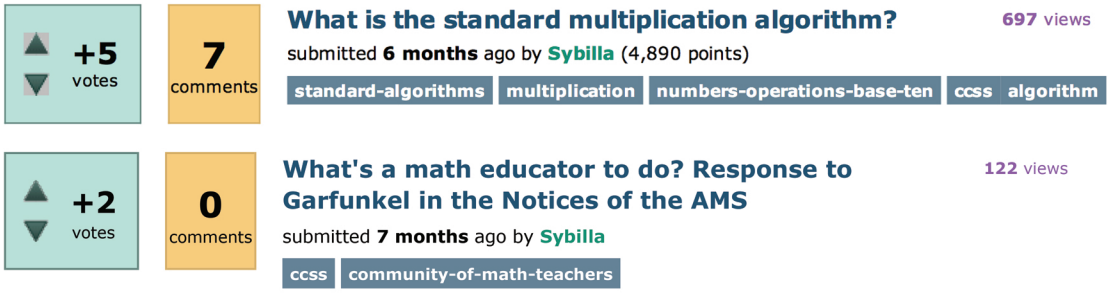

Figure 2. Some submissions under the "CCSS" tag.

not considered. You can teach and learn with and from others on the MTC.

On the MTC you can get feedback not just from your immediate colleagues, but from a much broader community of mathematics teachers from kindergarten through college. Hearing from people with different perspectives and being exposed to a diversity of ideas can spark your creativity and help you think about your teaching in new ways.

> Frazzled academic: "Cool! But I'm concerned about getting promotions and raises. How can I justify spending time on this?"

By interacting with others on the MTC, you can have impact on teaching beyond your institution. You can share how you have changed your teaching, which could inspire others to change their practice. If you are concerned about K–12 education, you might like to interact with K–12 teachers or with teacher-educators of K–12 teachers.

Your postings and comments on the MTC can earn you reputation points so that you have a tangible measure of your participation in the community. You could refer to your postings, comments, and reputation points to help you demonstrate your contributions to teaching. Perhaps this could even be useful in tenure and promotion.

> Frazzled academic: "This sounds great! But what if I get swamped for a few weeks?"

The MTC is forgiving—if you miss a few days because you are busy, it's still there. Unlike an individual blog, it doesn't all depend on you: the discussion can continue and the community as a whole moves forward while you come and go. So why not give it a try?

We have a vision of mathematics teaching as a vibrant profession in which we discuss issues of teaching and learning and build on each other's ideas. We think that mathematics teaching will become stronger if we join together—across all levels—to nurture our profession. There is much room for growth in mathematics teaching and much potential and thinking power that has not yet been tapped. We invite you to visit and look forward to hearing from you on the Mathematics Teaching Community.

Acknowledgments

We would like to thank Pete Clark and Kate Thompson for commenting on an earlier draft.

Mathematicians Discuss the Snowden Revelations

In the first part of 2013, Edward Snowden, a former contractor for the National Security Agency (NSA), handed over to journalists a trove of secret NSA documents. First described in the media in June 2013, these documents revealed extensive spying programs of the NSA and other governmental organizations, such as the United Kingdom's GCHQ (Government Communications Headquarters). The disclosures reverberated around the world, influencing the bottom lines of big businesses, the upper echelons of international relations, and the everyday activities of ordinary people whose lives are increasingly mirrored in the Internet and on cell phone networks.

The revelations also hit home in the mathematical sciences community. The NSA is often said to be the world's largest employer of mathematicians; it's where many academic mathematicians in the US see their students get jobs. The same is true for GCHQ in the UK. Many academic mathematicians in the US and the UK have done work for these organizations, sometimes during summers or sabbaticals. Some US mathematicians decided to take on NSA work after the 9/11 attacks as a contribution to national defense.

Another tie to the mathematical sciences community comes through the Mathematical Sciences Program (MSP), which the NSA launched in the mid-1980s (see `http://www.nsa.gov/research/math_research/`). The MSP provides grants for unclassified research by individuals, conferences, research experiences for undergraduates, and a few other infrastructure projects, as well as for sabbaticals at the NSA. While the program is quite small—due to recent cuts, its budget is expected to be US$4 million in 2015—it is a significant source of support for some areas of mathematics. Since the early 1990s, the AMS has assisted with administration of the program by convening panels to review proposals for individual grants and for conferences, and to make recommendations to the NSA about which ones to fund.

On the suggestion of one of us (Harris), the *Notices* decided to host a discussion of the NSA. (The controversy over GCHQ is in many ways similar, but the *Notices*, being the journal of record of the AMS, is focusing on NSA.) Three unsolicited pieces arrived to open the discussion even before we had finalized plans for its format (all of the following articles are available at `http://www.ams.org/notices`):

> *Letter to the Editor:* "AMS Should Sever Ties with the NSA", by Alexander Beilinson (December 2013)
>
> *Opinion:* "Dear NSA: Long-Term Security Depends on Freedom", by Stefan Forcey (January 2014)
>
> *Communication:* "The NSA Back Door to NIST", by Thomas C. Hales (February 2014)

Other discussion of the issue includes an article by Edward Frenkel, "The perils of hacking math", which appeared in the online magazine *Slate* on September 30, 2013. Mathematicians in the US are not alone in feeling an urgent need for a public discussion of the implications of their institutional relations with surveillance agencies. The April 2014 issue of the *London Mathematical Society Newsletter* carried an opinion piece, "Should mathematicians cooperate with GCHQ?", by Tom Leinster of the University of Edinburgh (see `http://newsletter.lms.ac.uk`). Soon thereafter, Leinster wrote "Maths spying: The quandary of working for the spooks", which appeared in the April 23, 2014, issue of *New Scientist* magazine (see `http://www.newscientist.com`). That article was syndicated in *Slate* and sparked international media coverage, including articles on the French website Mediapart and in the German magazines *Der Spiegel* and *Die Zeit* online.

Over the past several months we have solicited articles from mathematicians whom we believed would have useful and informative views on this subject. Two of the resulting articles appear here. Both articles, as well as the other pieces mentioned above, are critical of the NSA. In aiming to present a balanced discussion representing a variety of views, we made many efforts to seek out authors

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whom we thought might write in defense of the NSA. However, this proved difficult; some of those who turned us down might be under legal restrictions that greatly limit what they can say in public. We are continuing our efforts and intend in future issues to publish additional articles representing other viewpoints.

In his *New Scientist* piece, Tom Leinster writes, "Mathematicians must decide: do we cooperate with the intelligence services or not?… we mathematicians should talk about this." Frenkel, drawing a parallel with the ethical questions physicists faced with the invention of nuclear weapons, writes, "Members of my community must initiate a serious discussion about our role in this brave new world." What do you think? We look forward to hearing your opinions on these and similar questions. We also welcome all suggestions about how to make this discussion a thoughtful and informative one. Unsolicited submissions are welcome. Inquiries and submissions may be sent to notices-snowden@ams.org. Articles of 800 words or less are preferred. Those that are of 400 words or less can be considered as Letters to the Editor and should be sent to notices-letters@ams.org.

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The NSA: A Betrayal of Trust

Keith Devlin

Both as an American citizen and as a citizen in what is a highly integrated global society, I have opinions on many aspects of NSA surveillance. As someone who became a US citizen by choice, I have spent much time reflecting on what it means (or should mean) to be a citizen in a nation having so much power.

Since the Snowden revelations first broke, I have expressed those opinions publicly on social media and in a small number of published interviews that, like a great deal of information these days, can easily be accessed with a few keystrokes. In this article, written in response to an invitation from the *Notices of the American Mathematical Society*, I will focus on the one area where my opinion is informed by my mathematical expertise and five years of in-depth, Department-of-Defense-funded research in the area of extracting actionable information from vast amounts of data.

I concentrate on whether indiscriminate "vacuuming up" of personal information that, according to the documents Edward Snowden has released, the NSA has routinely engaged in for several years can effectively predict terrorist attacks. I'll say up front that, based on everything I learned in those five years, blanket surveillance is *highly* unlikely to prevent a terrorist attack and is a dangerous misuse of resources that, *if used in other ways, possibly could prevent attacks* (such as the 2013 Boston Marathon bombing). Anyone with a reasonable sense of large numbers could surmise a similar conclusion. When the goal is to identify a very small number of key signals in a large ocean of noise, indiscriminately increasing the size of the ocean is self-evidently not the way to go.

I reach my conclusion having spent five years looking at this problem in depth. From early 2002 until the middle of 2006, I worked on a Defense Department research project called NIMD (Novel Intelligence from Massive Data, http://www.sourcewatch.org/index.php?title=Novel_Intelligence_from_Massive_Data), funded by ARDA, the Advanced Research and Development Agency (http://www.sourcewatch.org/index.php/Advanced_Research_and_Development Activity). I did so under contract to Veridian Inc. It was a nonclassified project. I never sought nor had security clearance. Those of us involved were free to publish our results, but we were asked not to make public statements about the project or our involvement. I was happy to go along with that request. In particular, I never mentioned this work in any of my "Math Guy" appearances on National Public Radio nor in any of my regular columns for the Mathematical Association of America.

The only reason I am putting these words down now is the feeling of intense betrayal I suffered when I learned how my government and the leadership of my intelligence community took the work I and many others did over many years, with a genuine desire to prevent another 9/11 attack, and subverted it in ways that run totally counter to the founding principles of the United States, that cause huge harm to the US economy, and that moreover almost certainly *weaken* our ability to defend ourselves. During the project, I interacted with many other individuals, including other academic researchers, intelligence workers, and a few government and military personnel. Nevertheless, what my words express below is my considered and informed *opinion*. I never had, nor do I now have, access to any information beyond what is publicly available.

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Over the course of my work on NIMD, I saw systems demonstrated under nonclassified circumstances that, in a few seconds, could produce incredibly detailed and deeply personal profiles of individuals based on an Internet search that pulled in many isolated *publicly available* facts. So when I hear officials from President Obama down say, "It's just metadata," I smell a deliberate attempt to mislead the population they are supposed to serve.

Metadata tells you practically everything you need to know! In fact, much of the focus of my NIMD work was on the degree to which contextual features of signals (information sources) play a role in the knowledge that can be acquired from that signal. I was asked to join Veridian's project in NIMD precisely to look at that issue.

The invitation to join the Veridian team that successfully bid for one of the thirteen NIMD projects that were eventually funded came as a result of research I had carried out since the late 1980s, much of which was summarized in a series of books [1]–[4]. That research focused on analyzing the role played by different kinds of contexts in the acquisition and transmission of information. Having pursued that research for many years in a purely academic fashion, I was at first surprised to find that in the early post-9/11 world, it suddenly occupied a central position.

Well, not exactly central. My work occupied one edge of the central focus of NIMD. While a lot of the program's research was focused on developing technologies that would (they hoped) in future help the US intelligence community "connect the dots" in order to prevent another terrorist attack, the Veridian project was from the start focused on trained human analysts. The mission was to find ways to make them better. In our project, cognitive science and psychology played a far greater role than writing code. So we spent a lot of time thinking about what happened to any results that the ever bigger and more powerful computer systems spewed out. How could we take an impossibly large amount of data and produce a human-sized output that a trained analyst could make effective use of? It would involve filtering, condensing, fusing, and processing information to a truly gigantic degree to provide that analyst (actually a team of analysts) with something manageable. And that was just the first step. That analyst would have to take his or her conclusions and start a cascade of persuasion and decision-making running up through the command chain until it landed on the desk of a person who could initiate an action—an action having huge ramifications for public safety, the pursuit of which would carry the risks of danger to many people and of possible massive political fallout.

That highly significant, human part of the decision chain tends to be totally overlooked when intelligence leaders and politicians talk in glowing terms about the safety yielded by massive data processing of huge trawls of information. But it should not be ignored. It is a crucial factor. It's also the factor I spent four years trying to address and hence the one thing I want to add to the debate.

Data mining systems don't identify and take out terrorist groups; people do. And those people—and those who send them into harm's way on our behalf—require not only accurate information but sufficient meta-information (information about the origins and reliability of that information) to have confidence in any decision they make. Veridian asked me to investigate whether the largely theoretical ideas I had been pursuing in my research since the mid-1980s could be brought to bear on this problem.

I think I am not being unfair to any of the many really talented teams that worked on NIMD when I say that we did not find a way to analyze vast amounts of wide-focused (i.e., not focused) intelligence data and provide intelligence analysts with the kind of information they needed to take preventive action, given all that would entail. On the contrary, everything we learned made it even clearer that such was an impossible goal.

I was, for example, not at all surprised to learn that the Boston Marathon bombers were on counterterrorist watch lists all the time they were planning and then carrying out their heinous act. That does not indicate a "failure" of counterterrorism. I guarantee that the massive computer data searches were turning up hundreds (maybe thousands; I have no way of knowing) of cases that had similar profiles. Even if an intelligence agent were to "have a hunch" that one of those many cases was about to blow—and it really would have to be a hunch—what are the chances that it would make its way successfully up the command chain to produce effective countermeasures?

And the bigger you make the dataset, the wider the information trawl, the more unlikely that it will lead to an effective countermeasure. Thus, not only did NIMD fail to meet its goal, but as the data collection grew (we did not know about the pending degree of growth at the time, of course, nor its scope), the more inaccessible that goal became.

It is reasonable to assume that the number of genuine potential terrorists is small and not growing (at least not dramatically). Consequently, the bigger the data trawl, the harder it is to spot the bad guys, no matter how much computing power you bring to the problem.

What we did learn from NIMD—at least, what I took away from the experience (I cannot speak for everyone else, though others agreed with me)—is that the methods and tools we developed could be of real benefit *if they were utilized in a highly targeted way*.

That's the real NIMD message. Use of the search and analysis methods should be narrow and deep, not wide and shallow. Focus all those tools and all

that computing power on *deep* investigations of high-likelihood terrorists so that an intelligence analyst *can* be provided with all the information required to initiate a command chain call that *will* result in decisive action.

How do you identify those (relatively few) high-likelihood targets? The way intelligence communities always have: HUMINT (human intelligence). Not only is that the only effective way known, it does not require breaking laws and trampling the US Constitution. You get a court order and proceed lawfully. It's supposed to be the American way.

At the end of my NIMD work, I summarized some of what I had done in an unpublished paper that I posted on my Stanford homepage. It remains there to this day, dated July 15, 2005 (`http://www.stanford.edu/~kdevlin/Papers/Context_in_Reasoning.pdf`), bearing the annotation that it is an unfinished draft. In many ways, I wrote it as a road map of what to try next.

When I look back on that document now, it does not seem to represent much progress. (It also indicates that I was a very tiny cog in a very large engine. I made no major breakthroughs. I was just one among many mathematicians and others making small incremental steps in a very complex and messy domain.) On the other hand, when NIMD started in 2002, there wasn't even a sketch, let alone a road map.

After NIMD came to an end, I continued to pursue similar ideas in two subsequent Defense Department projects, first for a US naval contractor developing systems to process videos from surveillance drones, then a division of the US Army tasked with protecting US troops. When the army project came to an end in 2011, I assumed I would continue the work one way or another. I have, after all, learned a lot about this domain over the past twelve years.

But my purpose throughout has been to defend democratic freedom, not trample it. Personally, I would not trade freedom in order to prevent terrorist attacks, even if they were more frequent than the current de facto frequency of every ten years or so. If you do that, the terrorists have won. To give up those freedoms to run an Orwellian surveillance program that, based on the intelligence community's own research, is known to not only not work but to divert resources that if properly targeted (i.e., narrow and deep) could work, is completely wrong.

As things currently stand, I would not collaborate further with any of the US intelligence services. They have betrayed all of us who were glad to do what we could for the benefit of the free world and have used our work to trample over the Fourth Amendment, to do immense harm to US economic competitiveness, to weaken the Internet on which modern society depends, and to expose us to increased danger from our enemies (the latter two are "own-goals" that result from deliberately weakening the mathematical cryptosystems used in the Internet). I urge all my fellow mathematicians to take a similar stand.

References

[1] KEITH DEVLIN, *Logic and Information*, Cambridge University Press, 1991.

[2] KEITH DEVLIN and DUSKA ROSENBERG, *Language at Work: Analyzing Communication Breakdown in the Workplace to Inform Systems Design*, Center for the Study of Language and Information, Stanford University and Cambridge University Press, 1996.

[3] KEITH DEVLIN, *Goodbye Descartes: The End of Logic and the Search for a New Cosmology of the Mind*, Wiley, 1997.

[4] _____, *InfoSense: Turning Information into Knowledge*, W. H. Freeman, 1999.

The Mathematical Community and the National Security Agency

Andrew Odlyzko

The recent revelations about the NSA's spying programs are both dismaying and encouraging. What is encouraging is that they might lead not just to a reform of the intelligence agencies but also to a more serious look at what the ongoing and inevitable erosion of privacy is doing to our society. What is dismaying is less the intrusive data collection itself and more what it reveals about the decision-making processes inside the government.

These are all my personal opinions, but they are opinions based on over three decades of working on cryptography and security. Most of this time was in an industrial research lab. Currently, as a professor in a mathematics department, I regularly teach a course on cryptography. In addition, I am involved in a master's program on security technologies, where I lecture primarily on economics and psychology of security. I should also add that I have never had any kind of security clearance. Therefore I am not privy to any official secrets but at the same time am not restrained in expressing my opinions by any institutional ties.

My carefully considered view is that our society has become preoccupied with terrorism to an absurd and harmful degree. That is what has driven the intelligence agencies to the extreme measures

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they have taken. Are those measures illegal? Given the enthusiastic support they have generally received from the executive, legislative, and judicial branches of the government, this is debatable. However, as the famous saying goes, much of this activity is worse than a crime; it's stupid. Terrorism is a threat to our society, but it is simply not an existential threat that justifies extraordinary measures. We face a variety of threats—from car accidents, which take about as many lives each month as the 9/11 tragedy, to weather (ranging from sudden disasters, such as hurricanes Katrina and Sandy, to the dangers from climate change), to global avian flu pandemics. The moves taken in the name of fighting terrorism, including the intrusive NSA data collection that has recently come to light and more generally the militarization of our society, are not justified by the dangers we currently face from terrorism. In fact, these moves will likely inhibit our ability to deal with many of the other threats and probably will even inhibit the antiterrorism campaign.

Still, the antiterrorism mantra is driving public policy, and it is corroding the already weakened trust in democratic governance. When high-level officials feel free to give the "least untruthful" answers or provide assurances of careful oversight and of intelligence successes that are then shown to be false, much is lost. For democracy to thrive, people have to be able to rely on both the competence and honesty of officials. The recent events have demonstrated major failings on both counts.

The official reactions to the recent revelations about the NSA's programs reveal a striking persistence of delusions about data security in Washington. The Snowden data breach is regarded as a one-time event. Instead, as the Manning leak (or should I say torrent?) already showed earlier, it should be seen as inevitable. Such disclosures arise from the growth in volume of data, our demonstrated inability to build truly secure systems, and the need for wide information sharing inside the intelligence agencies if those agencies are to be effective. (Let's not forget that one of the key findings of the investigations of 9/11 was that extensive relevant information about the terrorists was available inside the US government but was not shared properly.) A reasonable working assumption should be that several foreign intelligence agencies have extracted similar troves of secrets from US collections (in addition to what they collect on their own) and that this will continue.

The likelihood of a continuing leakage of official secrets is just one consequence of the rapid growth of data. The NSA projects revealed by Snowden are just a forerunner of more serious issues. Most of the data that the NSA has been using came from private organizations, and those are building their business cases on ever more intrusive data collection and exploitation. One report from the latest Consumer Electronics Show said that the "unsettling message" of that event was that "everything will be tracked." What the NSA has been amassing is tiny compared to what will be available soon. Further, most of that will be held in databases much more poorly protected than those of the NSA. Therefore we will have to worry about more than government officials misusing the data for political or other purposes (as J. Edgar Hoover infamously did, but, as far as we know, the NSA has not done recently), or NSA employees tracking their romantic interests (as they apparently have done in many instances). We will also have to watch out for what might be done by even less trustworthy employees of the private organizations controlling that data and by all those who manage to break into those (inevitably insecure) databases.

We will need to figure out how to live in a world where practically everything we not just say or write but even feel (at the physical level, as measured by a variety of sensors that are coming and are sure to be embraced for their health benefits) will be recorded. Therefore, it will potentially be available not just to the NSA but to all those who gain legitimate or illegitimate access to it. Just what laws, regulations, and other measures we as a society adopt to deal with these problems is a very thorny issue to which far more attention should be paid. I hope that the Snowden revelations will stimulate more serious consideration of these issues.

Given the ongoing erosion of privacy, the NSA programs we have learned about do not seem too serious. It's not that I approve of them. I do regard them as largely unnecessary and harmful and, in some cases, such as the deliberate weakening of security standards, inexcusable. I am in favor of curtailing those programs, bringing them under more rigorous oversight, and making them more open. However, I do not see the NSA as a rogue organization engaging in amoral activities. What it has been doing has been done with wide support of almost all responsible officials (even though this support was often gained with the help of large doses of obfuscation, fear, uncertainty, and doubt) and is not that far beyond what various private organizations have been doing. The NSA fills an important role both in spying on numerous hostile actors and setting security standards, and in protecting our information infrastructure. And mathematics plays a key part in enabling those functions. Hence, while I do favor reforms, I do not support the argument for the mathematical community to sever its ties to the NSA, and I do not discourage my students from applying there for jobs.

Sinai Awarded 2014 Abel Prize

Photo courtesy of Princeton University Mathematics Department.

Yakov Sinai

The Norwegian Academy of Science and Letters has awarded the Abel Prize for 2014 to YAKOV SINAI of Princeton University and the Landau Institute for Theoretical Physics of the Russian Academy of Sciences "for his fundamental contributions to dynamical systems, ergodic theory, and mathematical physics." The Abel Prize recognizes contributions of extraordinary depth and influence in the mathematical sciences and has been awarded annually since 2003. The prize carries a cash award of approximately US$1 million. Sinai received the Abel Prize at a ceremony in Oslo, Norway, on May 20, 2014.

Citation

Ever since the time of Newton, differential equations have been used by mathematicians, scientists, and engineers to explain natural phenomena and to predict how they evolve. Many equations incorporate stochastic terms to model unknown, seemingly random, factors acting upon that evolution. The range of modern applications of deterministic and stochastic evolution equations encompasses such diverse issues as planetary motion, ocean currents, physiological cycles, population dynamics, and electrical networks, to name just a few. Some of these phenomena can be foreseen with great accuracy, while others seem to evolve in a chaotic, unpredictable way. Now it has become clear that order and chaos are intimately connected: we may find chaotic behavior in deterministic systems, and conversely, the statistical analysis of chaotic systems may lead to definite predictions.

Yakov Sinai has made fundamental contributions in this broad domain, discovering surprising connections between order and chaos and developing the use of probability and measure theory in the study of dynamical systems. His achievements include seminal works in ergodic theory, which studies the tendency of a system to explore all of its available states according to certain time statistics, and in statistical mechanics, which explores the behavior of systems composed of a very large number of particles, such as molecules in a gas.

Sinai's first remarkable contribution, inspired by Kolmogorov, was to develop an invariant of dynamical systems. This invariant has become known as the Kolmogorov-Sinai entropy, and it has become a central notion for studying the complexity of a system through a measure-theoretical description of its trajectories. It has led to very important advances in the classification of dynamical systems.

Sinai has been at the forefront of ergodic theory. He proved the first ergodicity theorems for scattering billiards in the style of Boltzmann, work he continued with Bunimovich and Chernov. He constructed Markov partitions for systems defined by iterations of Anosov diffeomorphisms, which led to a series of outstanding works showing the power of symbolic dynamics to describe various classes of mixing systems.

With Ruelle and Bowen, Sinai discovered the notion of SRB measures: a rather general and distinguished invariant measure for dissipative systems with chaotic behavior. This versatile notion has been very useful in the qualitative study of some archetypal dynamical systems, as well as in the attempts to tackle real-life complex chaotic behavior such as turbulence.

Sinai's other pioneering works in mathematical physics include random walks in a random environment (Sinai's walks), phase transitions (Pirogov-Sinai theory), one-dimensional turbulence (the statistical shock structure of the stochastic Burgers equation, by E-Khanin-Mazel-Sinai), the renormalization group theory (Bleher-Sinai), and the spectrum of discrete Schrödinger operators.

Sinai has trained and influenced a generation of leading specialists in his research fields. Much of his research has become a standard toolbox for mathematical physicists. His works had and continue to have a broad and profound impact on mathematics and physics, as well as on the ever-fruitful interaction of these two fields.

Biographical Sketch

Yakov G. Sinai was born on September 21, 1935, in Moscow, Russia. Both of his parents, Gregory Sinai and Nadezda Kagan, were microbiologists with research careers. His grandfather, the mathematician Benjamin Fedorovich Kagan, was head of the Department of Differential Geometry at Moscow State University. Kagan had great influence on his grandson. He retired from his chair at Moscow State University in 1952, the year in which his

grandson Yakov Grigorevich entered the Faculty of Mechanics and Mathematics.

Sinai received his B.S. (1957), his Ph.D. (1960), and his doctorate (1963) from Moscow State University. His advisor was the prominent Andrey Kolmogorov. Sinai was a scientific researcher at the Laboratory of Probabilistic and Statistical Methods at Moscow State University from 1960 to 1971. In 1971 he became a professor at Moscow State University and a senior researcher at the Landau Institute of Theoretical Physics, Russian Academy of Sciences. Since 1993 he has been a professor of mathematics at Princeton University but has concurrently kept his position at the Landau Institute of Theoretical Physics. During 1997–1998 Sinai was Thomas Jones Professor at Princeton University and in 2005 he was Moore Distinguished Scholar at the California Institute of Technology in Pasadena, California.

Sinai is one of the most influential mathematicians of the twentieth century. He has achieved numerous groundbreaking results in the theory of dynamical systems, in mathematical physics, and in probability theory. Many mathematical results are named after him, including Kolmogorov-Sinai entropy, Sinai's billiards, Sinai's random walk, Sinai-Ruelle-Bowen measures, and Pirogov-Sinai theory. Sinai is highly respected in both physics and mathematics communities as the major architect of the most bridges connecting the world of deterministic (dynamical) systems with the world of probabilistic (stochastic) systems. Perhaps it is only to be expected that he is the author of an article titled "Mathematicians and physicists = cats and dogs?" (*Bulletin of the American Mathematical Society (NS)* **43** (2006), no. 4, 563–565).

During the past half-century Sinai has written more than 250 research papers and a number of books. Sinai and his wife, Elena B. Vul, a mathematician and physicist, have also written a number of joint papers. Sinai has supervised more than fifty Ph.D. students.

The deep contributions made by Sinai early in his career led to his being invited to lecture at the International Congress of Mathematicians in Stockholm in 1962. Sinai has since been an invited speaker at several important international conferences and has given many prestigious lectures worldwide. He has spoken four times at the International Congress of Mathematicians. He was a plenary speaker at the First Latin American Congress in Mathematics in 2000. In 2001 he was appointed Chairman of the Fields Medal Committee of the International Mathematical Union, which decided on the awards of the Fields Medals at the Congress in Beijing in the following year.

Sinai has received many distinguished international awards. In 2013 he was awarded the Leroy P. Steele Prize for Lifetime Achievement from the American Mathematical Society. Other awards include the Wolf Prize in Mathematics (1997), the Nemmers Prize in Mathematics (2002), the Henri Poincaré Prize from the International Association of Mathematical Physics (2009), and the Dobrushin International Prize from the Institute of Information Transmission of the Russian Academy of Sciences (2009). Among his many recognitions are the Boltzmann Gold Medal from the Commission on Statistical Physics of the International Union of Pure and Applied Physics (1986) and the Dirac Medal from the Abdus Salam International Centre for Theoretical Physics in Trieste (1992).

Many mathematical societies and academies have elected Sinai to membership or honorary membership: the American Academy of Arts and Sciences (1983), the Russian Academy of Sciences (1991), the London Mathematical Society (1992), the Hungarian Academy of Sciences (1993), the United States National Academy of Sciences (1999), the Brazilian Academy of Sciences (2000), the Academia Europaea (2008), the Polish Academy of Sciences (2009), and the Royal Society of London (2009).

He has received honorary degrees from Warsaw University (1993), Budapest University of Science and Technology (2002), the Hebrew University in Jerusalem (2005), and Warwick University (2010). Sinai is also respected as a teacher at Princeton. In the words of a former student, "It's quite inspirational to be in his class…. People feel an immediate urge to participate—there is a radiance which comes from him and inspires us." He is also known for his persistence in the face of obstacles, be they bureaucratic or theoretical, a trait which has served him well throughout the years.

About the Prize

The Niels Henrik Abel Memorial Fund was established in 2002 to award the Abel Prize for outstanding scientific work in the field of mathematics. The prize is awarded by the Norwegian Academy of Science and Letters, and the choice of Abel Laureate is based on the recommendation of the Abel Committee, which consists of five internationally recognized mathematicians.

Previous recipients of the Abel Prize are Jean-Pierre Serre (2003), Michael Atiyah and I. M. Singer (2004), Peter Lax (2005), Lennart Carleson (2006), S. R. S. Varadhan (2007), John G. Thompson and Jacques Tits (2008), Mikhail L. Gromov (2009), John Tate (2010), John Milnor (2011), Endre Szemerédi (2012), and Pierre Deligne (2013).

—From an announcement of the Norwegian Academy of Science and Letters

Yitang Zhang Awarded Rolf Schock Prize

YITANG ZHANG of the University of New Hampshire has been awarded the Rolf Schock Prize in mathematics for 2014 "for his spectacular breakthrough concerning the possibility of an infinite number of twin primes."

In April 2013, Zhang, a relatively unknown lecturer at the University of New Hampshire, stunned the mathematical world with an article on one of the oldest unsolved problems in mathematics, the so-called "twin primes conjecture".

Prime numbers do not seem to appear randomly; rather, they exhibit several different regularities. Nevertheless, it is not possible to specify clear rules for where in the whole number sequence prime numbers will appear. It is known, however, that the further along the number sequence, the longer the distance between the primes—they become ever more rare. Do they ever stop appearing? The answer is no, and was given 2,300 years ago by Euclid of Alexandria, who proved that there are indeed infinitely many prime numbers.

A puzzling characteristic of prime numbers is that they sometimes appear in pairs, following each other. When separated only by 2, they are called twin primes. Are there an infinite number of such pairs? The proof of this so-called "twin prime conjecture" has been elusive. No one has yet been able to provide a definite answer, even though the question has engaged many well-known experts in analytical number theory. Yitang Zhang brought mathematics one important step closer to the answer. He managed to show that there are an infinite number of prime pairs for which the distance between the pair is less than 70 million. Zhang worked alone on the problem for many years, using an innovative approach, building on and developing previous work in various subfields of mathematics.

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His results were groundbreaking and spurred great activity around the world. In a few months, a team of mathematicians, led by Terence Tao of the University of California, Los Angeles, managed to shrink the distance between the prime numbers from 70 million to 4,680. A young postdoc at the University of Montreal, James Maynard, developed entirely new ideas and has now joined the collective endeavor. Together, they have reached the lowest limit of 270 between the primes in a pair. It remains uncertain, however, whether this distance can be reduced all the way down to 2.

Yitang Zhang was born in China in 1955 and studied mathematics at the University of Beijing. He moved to the USA in 1985 and defended his doctoral thesis at Purdue University in 1992. After that, he held various casual jobs until 1999, when he joined the University of New Hampshire, where he recently was appointed Professor of Mathematics. He was awarded the 2014 Cole Prize in Number Theory by the AMS, as well as the 2013 Ostrowski Prize.

The Rolf Schock Prizes are awarded every three years in the fields of logic and philosophy, mathematics, the visual arts, and the musical arts. The prize amount is 600,000 Swedish kronas, approximately US$93,000. They are awarded by the Royal Swedish Academy of Sciences, the Royal Swedish Academy of Fine Arts, and the Royal Swedish Academy of Music.

— From a Royal Swedish Academy of Sciences news release

Lamport Receives 2013 Turing Award

The Association for Computing Machinery (ACM) has announced that LESLIE LAMPORT, a principal researcher at Microsoft Research and developer of LaTeX, is the recipient of the 2013 A. M. Turing Award "for fundamental contributions to the theory and practice of distributed and concurrent systems, notably the invention of concepts such as causality and logical clocks, safety and liveness, replicated state machines, and sequential consistency." The award carries a cash prize of US$250,000 and will be presented to Lamport at the ACM annual awards banquet on June 21, 2014, in San Francisco.

According to the prize citation, Lamport was honored "for imposing clear, well-defined coherence on the seemingly chaotic behavior of distributed computing systems, in which several autonomous computers communicate with each other by passing messages. He devised important algorithms and developed formal modeling and verification protocols that improve the quality of real distributed systems. These contributions have resulted in improved correctness, performance, and reliability of computer systems.

"Lamport's practical and widely used algorithms and tools have applications in security, cloud computing, embedded systems, and database systems, as well as mission-critical computer systems that rely on secure information sharing and interoperability to prevent failure. His notions of safety, where nothing bad happens, and liveness, where something good happens, contribute to the reliability and robustness of software and hardware engineering design. His solutions for Byzantine Fault Tolerance contribute to failure prevention in a system component that behaves erroneously when interacting with other components. His creation of temporal logic language (TLA+) helps to write precise, sound specifications. He also developed LaTeX, a document preparation system that is the de facto standard for technical publishing in computer science and other fields."

Lamport originated many key concepts of distributed and concurrent computing, including "causality and logical clocks, replicated state machines, and sequential consistency." In collaboration with other researchers, "he invented the notion of Byzantine failure and algorithms for reaching agreement despite such failures. He contributed to the development and understanding of proof methods for concurrent systems, notably by introducing the notions of safety and liveness as the proper generalizations of partial correctness and termination to the concurrent setting."

Lamport received his Ph.D. in mathematics from Brandeis University in 1972. He has been a computer scientist with SRI International and Digital Equipment Corporation (later Compaq Corporation). He has authored or coauthored nearly 150 publications on concurrent and distributed computing and their applications. He received the IEEE Emanuel R. Piore Award in 2004 for his contributions to the theory and practice of concurrent programming and fault-tolerant computing. He was also awarded the Edsger W. Dijkstra Prize in Distributed Computing in 2005 for his paper "Reaching Agreement in the Presence of Faults". He is a recipient of the IEEE John von Neumann Medal (2008) and has been elected to the U.S. National Academy of Engineering and the U.S. National Academy of Sciences.

About the Award

The A. M. Turing Award was named for Alan M. Turing, the British mathematician who articulated the mathematical foundation and limits of computing and who was a key contributor to the Allied cryptanalysis of the German Enigma cipher during World War II. Since its inception in 1966, the Turing Award has honored the computer scientists and engineers who created the systems and underlying theoretical foundations that have propelled the information technology industry.

The award is given to an individual selected for contributions of a technical nature made to the computing community. The contributions should be of lasting and major technical importance to the computer field. Financial support for the Turing Award is provided by the Intel Corporation and Google Inc.

— ACM announcement

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The New IMU Needs You!

Herbert Clemens, Ingrid Daubechies, and Carol Wood

Prior to the 2006 International Congress of Mathematicians in Madrid, Spain, the article "The IMU and you" by then-president of the International Mathematical Union (IMU) John Ball described the work of the IMU, our professional world organization. (See *Notices of the AMS*, Vol. 52, No. 10, pp. 1208–1210.) The range of the IMU's activities has definitely changed since 2006. Most notable is an expanded set of activities aimed at fostering the growth of mathematics in the developing world.

Most of us are well aware of the International Congress of Mathematicians (ICM), which gives us the opportunity to enjoy hearing about some of the world's best mathematics, especially new developments during the previous four years, and to witness live the awarding of the Fields Medals, long mathematics' most prestigious prize.

But IMU could impinge on your life in many more ways. Would it appeal to you to travel to a developing country to teach a short course in your specialty to eager students? To exchange ideas about teaching with mathematicians and mathematics educators around the world? To write or translate a vignette about mathematics for the Klein blog? Or to make a tax-deductible donation to support the graduate studies of a young person on the way to becoming one of the first mathematics Ph.D.'s in his or her country? If any of these piques your interest, please read on.

ICM. Four years have rolled by since the last Congress took place in Hyderabad, India. The next ICM takes place August 12–23, 2014, in Seoul, South Korea. Information about ICM 2014 can be found at `http://www.icm2014.org/en/about/welcome`. In addition to high-level mathematics, there are many auxiliary activities, including panels on a wide range of topics, plus cultural events. There are also numerous specialized satellite meetings before and after the ICM. We encourage mathematicians to come and enjoy the rich variety of mathematics on display, as well as to enjoy the warm hospitality of our Korean colleagues.

IMU. The scientific union representing mathematics throughout the world is the IMU. Historically, the IMU has provided the organizational structure for selecting speakers and sites for the ICMs and for awarding the Fields Medals. The IMU is led by a president and an executive committee, with a secretariat charged with carrying out the IMU's business. Every four years, just prior to the ICM, the General Assembly (GA) of the IMU, consisting of delegates from the seventy-odd member countries, holds a two-day meeting during which it passes legislation concerning IMU policies and governance. The GA also elects the next executive committee and selects the site for the next ICM. Until recently, the IMU called home wherever the secretary of the IMU happened to be. It was decided in 2006 to call for proposals for a permanent office. The IMU understood that the permanent office would greatly simplify certain practical matters, including building institutional memory and making it easier to award funds to citizens around the world. It would also facilitate the IMU's goals for fostering mathematics. In 2010 the GA considered three attractive finalists, and the Weierstrass Institute in Berlin, Germany, was chosen as permanent host. The IMU's home base, supported by substantial funding from the German government, opened in January 2011 in a suite of rooms in the center of Berlin.

The U.S. participates in the IMU through the National Academy of Sciences, working via the U.S.

Herbert Clemens is CDC Secretary for Policy at the IMU. His email address is `clemens@math.utah.edu`.

Ingrid Daubechies is president of the IMU. Her email address is `ingrid@math.duke.edu`.

Carol Wood is a former chair of the USNC/M. Her email address is `cwood@wesleyan.edu`.

National Committee for Mathematics (USNC/M). Information about the USNC/M can be found at http://sites.nationalacademies.org/PGA/biso/IMU/index.htm.

Invitations to speak at an ICM are viewed as singular honors; even more prestigious and rare are the various prizes, including the Fields Medal and Nevanlinna Prize for outstanding mathematics by a researcher under forty, with Nevanlinna restricted to work in information sciences; the Gauss Prize in applied mathematics; and the newest ones, a medal named for Shiing-Shen Chern and awarded for lifetime achievement and the Leelavati prize for contributions to increase public awareness of mathematics. The IMU is also involved in the awarding of the Abel Prize and the Ramanujan Prize, but these are awarded outside the ICMs.

The IMU serves as the voice of mathematicians around the world in other ways. For instance, it collaborated with UNESCO on Mathematics of Planet Earth (MPE) Day at UNESCO in March 2013 and on the inauguration of an international Open Source MPE Exhibition to be presented at ICM 2014.

ICMI & CEIC. Historically, the IMU has had one standing commission, the International Commission on Mathematical Instruction (ICMI, pronounced "ick-me"), which was founded in Rome in 1908 and became a commission of the IMU in 1952. ICMI has a wide range of activities, including publications, workshops, and a prestigious quadrennial International Congress on Mathematical Education (ICME), all aimed at fostering the exchange of ideas and methods to improve the quality of mathematics education at all levels throughout the world. Recently, the annual Capacity and Network Projects have been held in several areas of the developing world, with the aim of building capacity in mathematics education and creating sustainable regional networks. Writing or translating a "vignette" for the Klein Project would be a very welcome way in which an AMS member could contribute to the work of the IMU. For examples of vignettes and to learn more about this program, see blog.kleinproject.org. In 1998, the Committee on Electronic Information and Communication (CEIC) was created. Information about ICMI and CEIC activities can be found via the links /icmi and /ceic at the home site http://www.mathunion.org.

CDC/VLP. The IMU's newest commission reflects a deepened understanding of the need for mathematical community across the globe. With the permanent office in 2011 came establishment and funding of the IMU's newest commission, the Commission for Developing Countries (CDC), building on earlier activities and collaborations among member countries. One important activity in which the USNC/M and U.S.-based mathematicians have been very much involved, is the Volunteer Lecture Program (VLP). In this program, mathematicians teach master's level courses of a few weeks' duration in countries lacking the infrastructure for mathematical instruction at that level. To date, the USNC/M, with support from the NSF, AMS (American Mathematical Society), SIAM (Society for Industrial and Applied Mathematics) and individuals, has sent over twenty-five mathematicians to teach in programs in Algeria, Cambodia, El Salvador, Nigeria, and Tanzania. Those who have taught in these programs speak of them with great enthusiasm. The new CDC, administered and supported by the IMU office, will be able to expand this activity to other countries. The challenges are many, most especially identifying an appropriate host institution. The lecturers receive expenses but no salary, but the opportunity to teach eager students in the developing world proves to be sufficient attraction. When a call went out a few years ago for U.S. participants in the VLP, there was a great response. Other countries also participate in the VLP, notably Japan, France, Spain, the United Kingdom, and Norway.

In some cases a country could not support even a master's program, but we were able to send a few students to nearby programs, using donations for scholarships. In this way Laotian students have attended the Cambodian program. University of Massachusetts professor Eduardo Cattani said about his experience teaching introductory real analysis at the Royal University of Phnom Penh that "I am convinced that for many of the students this Master's program is not only a career step but a transformative experience as well."

The cost of a scholarship for a student in such programs is minimal, and the potential impact for the student is enormous. Anyone wishing to contribute to these activities is invited to volunteer as a lecturer and/or to make tax-deductible contributions to Friends of the International Mathematical Union (FIMU), which is administered by the AMS. At present FIMU is considering a program through which U.S. mathematicians could "adopt" a graduate student in a developing nation. If you would be interested in this, please let us know!

MENAO. Another IMU activity in support of mathematical development in emerging nations is a day-long event called Mathematics in Emerging Nations: Achievements and Opportunities (MENAO). It will take place at the COEX Convention & Exhibition Center in Seoul, Korea, on Tuesday, August 12, 2014, just prior to the opening ceremonies of the 2014 International Congress of Mathematicians and in the same location. The IMU wishes to make MENAO a premier event, of compelling interest to all organizations, governmental agencies, and individuals that have contributed to international mathematical development or are potentially interested in doing so. About 100 MENAO participants/discussants will take part by

invitation, and observers will be admitted via registration on a first-come, first-served basis.

The MENAO event will benefit from a remarkable act of generosity by Korea, the host country for ICM 2014. Korea has itself experienced a phenomenal mathematical development over the last fifty years, one that proceeded hand-in-hand with its economic and educational development. As an act of solidarity with their colleagues in emerging nations, the Korean ICM hosts are currently inviting 1,000 mathematicians and advanced mathematics graduate students from the developing world to attend ICM 2014 ("NANUM 2014" invitation program), all expenses paid. (Nanum is a Korean word meaning "gracious and unconditional sharing".)

The goal of the MENAO event is to listen to the voices of mathematicians and aspiring advanced students of mathematics from the developing world: to share success stories of development via partnerships between the local mathematical communities, their governments, and international agencies and foundations and to review the current status of those efforts and future needs. The latter topic will be consolidated in a series of recently written "regional reports" that IMU will make available at the MENAO event.

The MENAO event will feature personal stories of mathematicians, country-specific development stories, both from the perspective of mathematicians in those countries and from the perspective of their international partners. An in-depth look at the Korean story will be narrated by key figures in the various stages of its mathematical development. Finally, relationships between mathematical development and economic development will be explored by internationally renowned economists.

WiM. A recent initiative at the IMU aims to provide resources for women in mathematics. Opportunities for women vary widely among countries, and IMU is currently establishing a website with an array of links aimed at supplying information and encouragement. This Women in Mathematics (WiM) initiative involves IMU staff working with an international advisory board of senior women mathematicians. Other activities focused on women at the ICM have included the ICM Emmy Noether Lecture, first given at ICM 1994 under the sponsorship of the Association for Women in Mathematics (AWM), then made a permanent activity under the IMU aegis at the 2010 GA. The International Congress of Women Mathematicians (ICWM) was held in Hyderabad on the two days prior to ICM 2010, organized by the European Women in Mathematics (EWM), the European Mathematical Society, and AWM, alongside a local committee doing the hard work on site. The organization of future ICWMs is now part of IMU's charge, again with assistance from organizations such as AWM and EWM. In 2014 the ICWM will be hosted by the Korean Women in Mathematical Sciences (KWMS). A full day's meeting will be held at Ewha Womans University on August 12, and then ICWM will continue at the ICM site on August 14, the afternoon of the ICM Emmy Noether Lecture. For details see `https://sites.google.com/site/icwm2014/`.

ICSU. There is an outer layer of the union above, namely the International Council for Science (ICSU, pronounced "ick-sue"), founded in 1931. The "U" here is vestigial, from an older name ending in Scientific Unions. ICSU is comprised of thirty-one Scientific Union Members, including the IMU, 120 National Scientific Members from 140 countries, and twenty-two International Scientific Associates. ICSU supports freedom and responsibility in science. It is the voice of the scientific community at the United Nations on programs related to climate change and sustainability, and it works for the accessibility and preservation of relevant data. ICSU networks the scientific unions through meetings and its grant program. One ICSU grant allowed the IMU to organize a summer school "Mathematics of climate change, related hazards and risks", jointly with the International Union of Geodesy and Geophysics (IUGG) and the International Union of Theoretical and Applied Mechanics (IUTAM) in July 2013. The ICSU grant program also has ICMI's Capacity and Network Projects (CANP) described above. ICSU deserves to be better known by mathematicians and is a candidate for a future *Notices* article. Until then, please see `http://www.icsu.org` to learn more about the wide variety of ICSU activities.

Developing a 21st Century
GLOBAL LIBRARY
for Mathematics Research

Sponsored by the Sloan Foundation, the IMU's Committee on Electronic Information and Communication (CEIC) and the U.S. National Academies Board on Mathematical Sciences and Their Applications (BMS) have just completed a preliminary study of what it would take to coordinate a Global Library for mathematical researchers, and what such an effort could make possible.

The IMU's CEIC organized a workshop in Washington, DC, in June 2012, to review existing efforts; then the BMS commissioned an NRC report, which was published a few weeks ago. It can be obtained from the National Academies Press (`www.nap.edu`) or from the arXiv (**arXiv:1404.1905**).

The Sloan Foundation, IMU, and BMS are now gathering feedback before they proceed to the next steps. There will be a panel discussion on this topic at ICM 2014 in Seoul, on August 20; another one is planned for JMM 2015.

Mathematics People

2013–2014 AMS Centennial Fellowship Awarded

Photo courtesy of Kate Juschenko.

Kate Juschenko

The AMS has awarded its Centennial Fellowship for 2014–2015 to KATE JUSCHENKO of Northwestern University. The fellowship carries a stipend of US$85,000, an expense allowance of US$8,500, and a complimentary Society membership for one year.

Kate Juschenko was born in Kiev, Ukraine. She attended Kiev National University for her bachelor's degree and completed her Ph.D. at Texas A&M University in 2011 under the direction of Gilles Pisier. She has been an assistant professor at Vanderbilt University, Nashville, and a postdoctoral fellow at EPFL, Lausanne. In 2013 she was appointed an assistant professor at Northwestern University.

Juschenko's research began in the field of operator spaces and operator algebras. In later research she has primarily concentrated on amenability of groups and analytic aspects of group theory.

Please note: Information about the competition for the 2015–2016 AMS Centennial Fellowships will be published in the "Mathematics Opportunities" section of an upcoming issue of the *Notices*.

—Allyn Jackson

Zhang Awarded Ostrowski Prize

YITANG ZHANG of the University of New Hampshire has been awarded the 2013 Ostrowski Prize for outstanding mathematical achievement. The prize carries a monetary award of 75,000 Swiss francs (approximately US$85,000).

Zhang was honored "for his breakthrough work on small gaps between prime numbers." The prize citation reads in part: "Let $p_1,p_2,\dots$ denote the increasing sequence of prime numbers. It follows from the prime number theorem that the average gap between consecutive prime numbers p_{n+1} and p_n is roughly $\log p_n$ in size. What can be said about small gaps between consecutive primes? Erdős, in 1940, was the first to prove that there is a positive number c which is smaller than 1 such that $p_{n+1}-p_n<c\log p_n$ for infinitely many positive integers n. This result was refined by Bombieri and Davenport, Huxley, Maier, and others. In particular, Maier proved that the preceding equation holds with $c=.248\dots$ in 1988. Next Goldston, Pintz, and Yıldırım established, in a pair of papers which appeared in 2009 and 2010, that a much stronger result is true. They proved that there is a positive number C such that $p_{n+1}-p_n< C(\log p_n)^{1/2}(\log\log p_n)^2$ for infinitely many positive integers n. Building on the work of Goldston, Pintz, and Yıldırım, Zhang proved in 2013 that $p_{n+1}-p_n<7\cdot10^7$ for infinitely many positive integers n. This represents a stunning step forward and brings the twin prime conjecture into view. Zhang's proof employs many powerful ideas from analytic number theory including the sieve of Goldston, Pintz, and Yıldırım; the Bombieri-Vinogradov theorem; Weil's bound for Kloosterman sums; Deligne's proof of the Riemann hypothesis for varieties over finite fields; and the work of Bombieri, Friedlander, and Iwaniec on the distribution of primes in arithmetical progressions. It is a landmark achievement."

Yitang Zhang was born in China in 1955 and studied mathematics at the University of Beijing. He moved to the United States in 1985 and defended his doctoral thesis at Purdue University in 1992. He joined the University of New Hampshire in 1999 and is currently professor of mathematics. He was awarded the 2014 Cole Prize in Number Theory by the AMS and the Rolf Schock Prize in mathematics for 2014.

About the Prize

The Ostrowski Foundation was created by Alexander Ostrowski, for many years a professor at the University of Basel. He left his entire estate to the foundation and stipulated that the income should provide a prize for outstanding recent achievements in pure mathematics and the foundations of numerical mathematics. The prize is awarded every other year.

—From an Ostrowski Foundation announcement

Hughes-Oliver to Receive 2014 Blackwell-Tapia Prize

JACQUELINE M. HUGHES-OLIVER of North Carolina State University has been awarded the 2014 Blackwell-Tapia Prize. She has made important contributions in a number of statistical research areas, including methodological research on prediction and classification, variable and model selection with dimension reduction, design of experiments, and spatial modeling. Application areas of her research include drug discovery, environmental modeling, transportation modeling, engineering manufacturing,

genomics, and metabolomics. She has worked passionately on the cause of increasing diversity of individuals working in the statistical and mathematical sciences.

The Blackwell-Tapia Prize is awarded every other year in honor of the legacy of David H. Blackwell and Richard A. Tapia, two distinguished mathematical scientists who have been inspirations to more than a generation of African American, Latino/Latina, and Native American students and professionals in the mathematical sciences. The prize will be presented at the eighth Blackwell-Tapia Conference, to be held at the Institute for Pure and Applied Mathematics (IPAM) in November 2014.

—From an IPAM announcement

Moore Awarded Heineman Prize

GREGORY W. MOORE of Rutgers University has been awarded the 2014 Dannie Heineman Prize in Mathematical Physics for his "eminent contributions to mathematical physics with a wide influence in many fields, ranging from string theory to supersymmetric gauge theory, conformal field theory, condensed matter physics and four-manifold theory."

The Heineman Prize is awarded annually in recognition of outstanding publications in the field of mathematical physics. The prize consists of US$10,000 and a certificate. It was established by the Heineman Foundation for Research, Educational, Charitable, and Scientific Purposes, Inc., and is administered jointly by the American Physical Society and the American Institute of Physics.

—From a Heineman Foundation announcement

Ruelle Receives Max Planck Medal

DAVID RUELLE of the Institut des Hautes Études Scientifiques (IHES) in Bures-sur-Yvette, France, has received the 2014 Max Planck Medal of the Deutsche Physikalische Gesellschaft (DPG, German Physical Society), the highest honor of the DPG in theoretical physics. Ruelle was honored "for his fundamental contributions to relativistic quantum field theory, statistical mechanics, and the theory of dynamical systems with applications to the problem of the onset of turbulence."

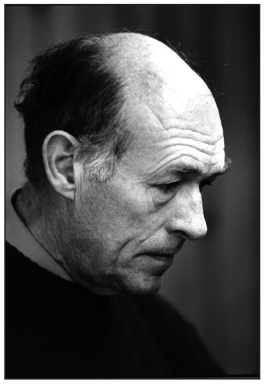

Photo courtesy of IHES.

David Ruelle

Ruelle has made fundamental and groundbreaking contributions to three central areas of modern theoretical physics: axiomatic quantum field theory, statistical mechanics, and the theory of dynamical systems. His works on scattering processes in quantum field theory, on the properties of thermal equilibrium and phase transitions, as well as the onset and nature of turbulence in liquids, are classics of modern mathematical physics. Among other things, Ruelle is the author of seven books, including *Statistical Mechanics: Rigorous Results* (1969).

Ruelle received his Ph.D. in 1959 from the Université Libre de Bruxelles. The basis of his Ph.D. thesis was work done at the Eidgenössische Technische Hochschule (ETH) Zurich under the guidance of Res Jost. After postdoctoral stays at the ETH Zurich and the Institute for Advanced Study in Princeton, Ruelle was appointed a professor at the IHES, where he has been working since 1964. Ruelle has received many honors for his research and is a member of five academies. He is also a Fellow of the AMS.

—From a DPG announcement

Levin Awarded Tyler Environmental Prize

SIMON A. LEVIN of Princeton University has been named the recipient of the 2014 Tyler Prize "for his research revealing the complexity of and relationships between species and ecosystems." His work has been fundamental in the crafting of environmental policies and advancing the study of complex ecosystems—the myriad relationships and interactions in nature." The prize citation reads in part: "Levin's research has led the way to a deeper understanding of the interactions among groups of plants and animals living together, to their impact on the environment, to the interplay of different ecosystems—forests, oceans, and tidal zones, for example. This research has revealed insights into evolution and the origins of biodiversity, leading to improved management of natural resources, like forests and fisheries, as well as broader environmental policies. Fundamentally, Levin's work on theoretical ecology—ecology based on mathematical modeling—has helped to put environmental research into context and provide a big picture for understanding our environment."

Levin received his Ph.D. in mathematics from the University of Maryland in 1964. His research interests include modeling of ecological systems; dynamics of populations and communities; spatial heterogeneity and problem of scale; evolutionary, mathematical, and theoretical ecology; evolution of cooperation; and maintenance of social norms.

The prize is awarded by the international Tyler Prize Executive Committee, with the administrative support of the University of Southern California, to honor exceptional foresight and dedication in the environmental sciences. It carries a cash award of US$200,000 and a gold medal.

—From a Tyler Prize Committee press release

Balinski Awarded von Neumann Prize

MICHEL L. BALINSKI of CNRS and École Polytechnique has been awarded the 2013 John von Neumann Theory Prize, the highest prize given in the field of operations research and management science. The prize citation recognizes his contributions in linear and nonlinear optimization, integer programming, convex polyhedra and combinatorics, and in the domain of electoral decisions: representation and apportionment and voting. He is coauthor of the books *Fair Representation: Meeting the Ideal of One Man, One Vote* and *Majority Judgment: Measuring, Ranking, and Electing*.

—From an INFORMS announcement

Prizes of the Canadian Mathematical Society

The Canadian Mathematical Society (CMS) has awarded a number of prizes for 2014.

GAIL WOLKOWICZ of McMaster University has been awarded the Krieger-Nelson Prize for her contributions to the study of differential equations, dynamical systems, and their applications. The prize recognizes women mathematicians who have made outstanding contributions in mathematical research. According to the prize citation, she researches mathematical models in biology, including preservation of species diversity, pest control, biological waste remediation, and the production of green energy that involve differential equations, using analytical and numerical tools from modern dynamical systems and bifurcation theory.

ASKOLD KHOVANSKII of the University of Toronto has been awarded the Jeffrey-Williams Prize for Research Excellence for his work in pure mathematics. According to the prize citation, he has done outstanding research in Galois theory, Newton polyhedra theory, the theory of fewnomials, and the theory of Newton-Okounkov bodies. The Jeffrey-Williams Prize is awarded annually to an individual who has made outstanding contributions to mathematical research in Canada.

MARCO GUALTIERI of the University of Toronto has been awarded the Coxeter-James Prize for young mathematicians who have made outstanding contributions in mathematical research for his work in special geometric structures. According to the prize citation, he works "at the interface between differential geometry and theoretical physics. The mathematical models developed by physicists to describe the behaviour and properties of the elementary forces in nature are comprised of many intricate 'moving parts', each of which is a system of geometric structures occupying various dimensions and often having interesting symmetries."

KENNETH R. DAVIDSON of the University of Waterloo has been awarded the 2014 CMS David Borwein Distinguished Career Award "in recognition of his exceptional, broad, and continued contributions to mathematics." According to the prize citation, he "has published well over 100 refereed publications in the areas of operator theory, nonselfadjoint operator algebras, and C^*-algebras, and his research in these areas has garnered attention worldwide. He is also the author of two research monographs and a real analysis textbook." He has helped to build a research group at Toronto "that is acclaimed for being one of the strongest functional and harmonic analysis groups" in Canada. He is a Fields Institute Fellow and a Fellow of the Royal Society of Canada.

—From CMS announcements

Tachikawa Awarded 2014 Hermann Weyl Prize

YUJI TACHIKAWA of the University of Tokyo has been named the recipient of the 2014 Hermann Weyl Prize "for outstanding contributions to our understanding of supersymmetric quantum field theories; in particular, to the discovery of the Alday-Gaiotto-Tachikawa correspondence that has led to spectacular advances in both mathematics and quantum physics." The prize recognizes young scientists under thirty-five years of age or who are within five years of receipt of the doctoral degree who have performed original work of significant scientific quality in the area of understanding physics through symmetries. The award will be presented at the International Colloquium on Group Theoretical Methods in Physics (ICGTMP) in July 2014.

—From an ICGTMP announcement

Salur Awarded Michler Prize

SEMA SALUR of the University of Rochester has been awarded the 2014–2015 Ruth I. Michler Memorial Prize of the Association for Women in Mathematics (AWM). Salur was selected for "her wide range of mathematical talents." Her research is in the area of manifolds with special holonomy and calibrations. In particular, she studies geometry and topology of the moduli spaces of calibrated submanifolds inside Calabi-Yau, G_2, and Spin(7) manifolds. At Cornell she will continue her work on manifolds with special holonomy and Ricci flat metrics. She plans to collaborate with Xiaodong Cao and Yuri Berest on projects related to the geometric flows on G_2 and Spin(7) manifolds. Understanding these flows will have many applications in mathematical physics and algebraic geometry. She also plans to work with Tara Holm and Reyer Sjamaar on calibrated submanifolds and special vector fields on manifolds with special holonomy.

Salur received her Ph.D. in mathematics from Michigan State University in 2000 under the direction of Gang Tian. She has been a visiting assistant professor at both Cornell University and Northwestern University and a research fellow at Princeton University, the Mathematical Sciences Research Institute (MSRI), and the Institute for Pure and

Applied Mathematics (IPAM). She has been on the faculty at the University of Rochester since 2006.

The Ruth Michler Prize grants a midcareer woman in academia a residential fellowship in the Cornell University mathematics department without teaching obligations.

—From an AWM announcement

Gamba Awarded Kovalevsky Lectureship

IRENE GAMBA of the University of Texas, Austin, has been chosen as the AWM-SIAM Sonia Kovalevsky Lecturer for 2014 by the Association for Women in Mathematics (AWM). She was honored "for her contribution to analytical and numerical methods for statistical transport problems in complex particle systems, and for her service to the applied mathematics community including serving in scientific, policy, and editorial committees and boards and training postdocs and graduate students including women applied mathematicians." Gamba received her Ph.D. from the University of Chicago in 1989 under the direction of Jim Douglas Jr. She has been affiliated with the Courant Institute of Mathematical Sciences and has held many visiting positions. She was elected to the inaugural class of Fellows of the AMS and is also a Fellow of the Society for Industrial and Applied Mathematics (SIAM). She is currently an editor for the *Journal of Mathematical Fluid Dynamics*. She will deliver the Kovalevsky Lecture, titled "The evolution of complex interactions in non-linear kinetic systems", at the 2014 SIAM annual meeting. The Sonia Kovalevsky Lectureship honors significant contributions of women to applied or computational mathematics.

—From an AWM-SIAM announcement

Milner Awarded 2014 PIMS Education Prize

SUSAN MILNER of the University of the Fraser Valley in British Columbia, Canada, has been awarded the 2014 Education Prize of the Pacific Institute for the Mathematical Sciences (PIMS). The prize recognizes individuals in Western Canada and Washington State who have played a major role in encouraging activities that have enhanced public awareness and appreciation of mathematics, as well as fostering communication among various groups concerned with mathematical education at all levels.

According to the prize citation, Milner's interests, in addition to teaching, include curriculum design and ways to make mathematics more accessible to a wide audience. She has brought the PIMS Math Mania program to many schools and has enhanced the program by adding such activities as origami and puzzles. She has given workshops for teachers from many schools and school districts.

—From a PIMS announcement

Sloan Fellowships Awarded

The Alfred P. Sloan Foundation has announced the names of the recipients of the 2014 Sloan Research Fellowships. Each year the foundation awards fellowships in the fields of mathematics, chemistry, computational and evolutionary molecular biology, computer science, economics, neuroscience, physics, and ocean sciences. Grants of US$50,000 for a two-year period are administered by each fellow's institution. Once chosen, fellows are free to pursue whatever lines of inquiry most interest them, and they are permitted to employ fellowship funds in a wide variety of ways to further their research aims.

Following are the names and institutions of the 2014 awardees in mathematics: NIR AVNI, Northwestern University; NAYANTARA BHATNAGAR, University of Delaware; MAKSYM FEDORCHUK, Boston College; JONATHAN HAUENSTEIN, North Carolina State University; KAI-WEN LAN, University of Minnesota; LIONEL LEVINE, Cornell University; IVAN LOSEU, Northeastern University; MARYANTHE MALLIARIS, University of Chicago; AMIR MOHAMMADI, University of Texas, Austin; AARON NABER, Northwestern University; DEANNA NEEDELL, Claremont McKenna College; MICHAEL J. NEILAN, University of Pittsburgh; BENOIT PAUSADER, Princeton University; CHARLES SMART, Massachusetts Institute of Technology; JARED SPECK, Massachusetts Institute of Technology; SAMUEL STECHMANN, University of Wisconsin, Madison; SONG SUN, Stony Brook University; BENJAMIN WEBSTER, University of Virginia; JARED WEINSTEIN, Boston University; JUN YIN, University of Wisconsin, Madison.

—From a Sloan Foundation announcement

Intel Science Talent Search Winners Announced

Three students whose work involves the mathematical sciences have received scholarship awards in the 2014 Intel Science Talent Search. KEVIN LEE, seventeen, of Irvine, California, was awarded second place and a US$75,000 scholarship for developing "a mathematical model to describe the shape of the heart as it beats using the principles of fluid mechanics. His faster and computationally efficient model could provide insights into arrhythmia and may lead to better treatments for the disease." WILLIAM HENRY KUSZMAUL, seventeen, of Lexington, Massachusetts, was awarded third place honors and a scholarship of US$50,000 for developing "a new approach to the mathematics of modular enumeration, which has applications to a wide number of problems in computer science, bioinformatics and computational biology." SHAUN DATTA of North Potomac, Maryland, was awarded tenth place and a scholarship award of US$20,000 for his research that used computer models and equations to improve our understanding of the interactions of nuclear matter.

—From an Intel Corporation announcement

Putnam Prizes Awarded

The winners of the seventy-fourth William Lowell Putnam Mathematical Competition have been announced. The Putnam Competition is administered by the Mathematical Association of America (MAA) and consists of an examination containing mathematical problems that are designed to test both originality and technical competence. Prizes are awarded to both individuals and teams.

The five highest ranking individuals, listed in alphabetical order, were: MITCHELL M. LEE, Massachusetts Institute of Technology; ZIPEI NIE, Massachusetts Institute of Technology; EVAN M. O'DORNEY, Harvard University; BOBBY C. SHEN, Massachusetts Institute of Technology; and DAVID H. YANG, Massachusetts Institute of Technology. Each received a cash award of US$2,500.

Institutions with at least three registered participants obtain a team ranking in the competition based on the rankings of three designated individual participants. The five top-ranked teams (with members listed in alphabetical order) were: first place, Massachusetts Institute of Technology (BENJAMIN P. GUNBY, MITCHELL M. LEE, ZIPEI NIE); second place, Carnegie Mellon University (MICHAEL DRUGGAN, LINUS HAMILTON, THOMAS SWAYZE); third place, Stanford University (VISHAL ARUL, RAVI FERNANDO, SAM G. KELLER); fourth place, Harvard University (OCTAV I. DRAGOI, EVAN M. O'DORNEY, ALLEN YUAN); fifth place, California Institute of Technology (XIANGYI HUANG, ZHAORONG JIN, TIAN NIE). The first-place team receives an award of US$25,000, and each member of the team receives US$1,000. The awards for second place are US$20,000 and US$800; for third place, US$15,000 and US$600; for fourth place, US$10,000 and US$400; and for fifth place, US$5,000 and US$200.

XIAO WU of Yale University received the Elizabeth Lowell Putnam Prize, awarded periodically to a woman whose performance in the competition has been deemed particularly meritorious. She received a cash award of US$1,000.

—From an MAA announcement

Shamai Awarded Rothschild Prize

SHLOMO SHAMAI of Technion/Israel Institute of Technology has been awarded the Rothschild Prize in Mathematics/Computer Science and Engineering "for his consistent, outstanding and original contributions to the field of information theory—the mathematical theory of communications—which serve as a beacon for state-of-the-art communications technologies." Rothschild Prizes are awarded by the Yad Hanadiv Foundation to support, encourage, and advance the sciences and humanities in Israel. Prizes are awarded in recognition of original and outstanding published work in the following disciplines: mathematics/computer sciences and engineering, chemical sciences and physical sciences, life sciences, Jewish studies, humanities and social sciences.

—From a Yad Hanadiv Foundation announcement

Hertz Fellowships Awarded

Two young mathematicians have been selected to receive 2014 Fannie and John Hertz Foundation Fellowships. GENE KATSEVICH of Princeton University and ANDREW RZEZNIK of the Massachusetts Institute of Technology will receive support of more than US$250,000 each for up to five years of graduate work. Fellows have the freedom to innovate in their doctoral studies without university or research restrictions.

—From a Hertz Foundation announcement

AWM Essay Contest Winners

The Association for Women in Mathematics (AWM) has announced the winners of its 2014 essay contest, "Biographies of Contemporary Women in Mathematics". The grand prize was awarded to NATHALIE SIEH, St. Cecelia Interparochial School, Clearwater, Florida, for her essay, "The Road Not Taken". The essay won first place in the middle school category and will be published in the *AWM Newsletter*. First place in the undergraduate-level category was awarded to TORY FIELDS of Ball State University, for the essay "Nora Moushey: Chief Actuary and Lifelong Learner". First place in the high school category was awarded to FRANCESCA PARIS of Head-Royce School, Oakland, California, for her essay "Dr. Kate Stevenson: Adding Value".

—From an AWM announcement

NSF Graduate Research Fellowships Awarded

The National Science Foundation (NSF) has awarded a number of Graduate Research Fellowships for fiscal year 2014. Further awards may be announced later in the year. This program supports students pursuing doctoral study in all areas of science and engineering and provides a stipend of US$30,000 per year for a maximum of three years of full-time graduate study. Following are the names of the awardees in the mathematical sciences selected so far in 2014, followed by their undergraduate institutions (in parentheses) and the institutions at which they plan to pursue graduate work.

JOSHUA H. ALMAN (Massachusetts Institute of Technology), Massachusetts Institute of Technology; LEVENT ALPOGE (Harvard University), Harvard University; ERIK W. BATES (Michigan State University), Michigan State University; KELLY N. BODWIN (Harvard University), University of North Carolina at Chapel Hill; ZARATHUSTRA E. BRADY (California Institute of Technology), Stanford University; BORIS BRIMKOV (State University of New York at Buffalo), Rice University; CLARK W. BUTLER (Ohio State University), University of Chicago; STEPHEN P. CAMERON (College of William and Mary), College of William and Mary;

Alexander J. Carney (University of Michigan, Ann Arbor), University College London; Alice Chan (Pomona College), Pomona College; Jeffrey D.-W. Chan (Massachusetts Institute of Technology), Massachusetts Institute of Technology; Alan Chang (Princeton University), Princeton University; Wan-Schwin A. Cheng (National Taiwan University), Johns Hopkins University; Sara Clifton (Colorado School of Mines), Northwestern University; William L. Cocke (Brigham Young University), Brigham Young University; Reid R. G. Dale (University of Washington), University of Washington; Brisa N. Davis (Whitworth University), University of Washington; Kristin M. Dettmers (California State Polytechnic University, Pomona), California State Polytechnic University, Pomona; Natalie C. Gasca (California State Polytechnic University, Pomona), California State Polytechnic University, Pomona; Samuel Gutekunst (Harvey Mudd College), Harvey Mudd College; Lynette Guzman (University of Arizona), Michigan State University; Erika Helgeson (Gonzaga University), University of North Carolina at Chapel Hill; Benjamin S. S. Hoffman (Lewis and Clark College); Amanda A. Howard (Stanford University), Brown University; Jessica Hwang (Harvard University), Stanford University; Jami N. Jackson (Columbia University), North Carolina State University; Arun Jambulapati (University of Memphis), University of Memphis; Nadine Y. Jansen (North Carolina Agricultural and Technical State University), North Carolina Agricultural and Technical State University; Michael Jemison (Harvard University), Princeton University; Eric Kightley (University of Cincinnati), University of Colorado at Boulder; Daniel J. Kriz (Princeton University), Princeton University; Miriam Kuzbary (University of Texas at Dallas), Rice University; Nathan J. L. Lenssen (Claremont McKenna College); Keli Liu (Harvard University); Molly M. Logue (University of Michigan), University of Michigan; Kristina M. Mallory (University of Central Florida), University of Central Florida; Akhil Mathew (Harvard University), Harvard University; Frederick N. McCollum (University of Arkansas), University of Arkansas; Katherine J. Meyer (Smith College), University of Minnesota, Twin Cities; Laurel A. M. Ohm (Saint Olaf College), University of Washington; Morgan P. Opie (University of Massachusetts, Amherst), University of Massachusetts, Amherst; Colin Pawlowski (Yale University), Yale University; Sarah A. Peluse (University of Chicago), University of Chicago; Yannik K. Pitcan (Harvard University), University of California Berkeley; Anna Plantinga (Calvin College), University of Washington; Joan L. Ponce (University of Florida); Christopher V. Rackauckas (Oberlin College), University of California Irvine; Andrew J. Rzeznik (Cornell University), Massachusetts Institute of Technology; Kevin R. Sackel (State University of New York at Stony Brook), Cambridge University; Anthony Sanchez (Arizona State University), Arizona State University; Kelly Spendlove (Montana State University), Rutgers University; Melissa Strait (Harvey Mudd College), North Carolina State University; Aubrey Thompson (University of Nebraska, Lincoln), University of Nebraska, Lincoln; Diego Torrejon (George Mason University), George Mason University; Catherine G. Triandafillou (Temple University); Minh-Tam Quang Trinh (Princeton University), Princeton University; Dennis Tseng (Massachusetts Institute of Technology), Massachusetts Institute of Technology; Jeremy Usatine (Harvey Mudd College), Harvey Mudd College; Saraswathi J. Venkatesh (California Institute of Technology), Columbia University; Isabel M. Vogt (Harvard University), Harvard University; Matthew K. Voigt (Saint John's University), University of Minnesota, Twin Cities; Joseph D. Walsh (Western Michigan University), Georgia Institute of Technology; Jane Wang (Princeton University), Princeton University; Andre K. Waschka (North Carolina State University), University of California Berkeley; Jonathan Weed (Princeton University); Lynnelle L. Ye (Stanford University), Stanford University; Evangelie M. L. Zachos (Princeton University), Princeton University; Andrew Zucker California Institute of Technology), Carnegie Mellon University.

—From an NSF announcement

2014 Guggenheim Fellowship Awards to Mathematical Scientists

The John Simon Guggenheim Memorial Foundation has announced the names of 178 scholars, artists, and scientists who were selected as Guggenheim Fellows for 2014. Selected as fellows in mathematics and applied mathematics, along with their areas of research, were: Kiran Kedlaya, University of California, San Diego, for work on computational aspects of the Langlands program; Doron Levy, University of Maryland, College Park, for work on dynamics of drug resistance in cancer; and Daniel Stein, New York University, for work on disordered systems, nonequilibrium dynamics, and stochastic processes. In addition, Carla Mazzio, University of Buffalo, was awarded a Guggenheim to work on her book *The Trouble with Numbers: The Drama of Mathematics in the Age of Shakespeare*. Guggenheim Fellows are appointed on the basis of distinguished achievement in the past and exceptional promise for future accomplishments.

—From a Guggenheim Foundation news release

SIAM Fellows Elected

The Society for Industrial and Applied Mathematics (SIAM) has elected thirty-two new fellows for 2014. Their names and institutions follow.

Mark Ainsworth, Brown University; John S. Baras, University of Maryland, College Park; Lorenz T. Biegler, Carnegie Mellon University; Ake Bjorck, Linkoping University; Alfred M. Bruckstein, Technion/Israel Institute of Technology; Suncica Canic, University of Houston; Inderjit S. Dhillon, University of Texas at Austin; Vladimir L. Druskin, Schlumberger-Doll Research; Leah Edelstein-Keshet, University of British

Columbia; DONALD ESTEP, Colorado State University; OMAR GHATTAS, University of Texas at Austin; PHILIP E. GILL, University of California, San Diego; SOLOMON W. GOLOMB, University of Southern California; JAN S. HESTHAVEN, École Polytechnique Federale de Lausanne; DORIT S. HOCHBAUM, University of California Berkeley; MASAKAZU KOJIMA, Tokyo Institute of Technology and JST CREST; JEFFREY C. LAGARIAS, University of Michigan; JEAN B. LASSERRE, Centre National de la Recherche Scientifique and Institute of Mathematics, University of Toulouse; TAI-PING LIU, Academia Sinica; MITCHELL B. LUSKIN, University of Minnesota; NANCY K. NICHOLS, University of Reading; PETER J. OLVER, University of Minnesota; YURIKO YAMAMURO RENARDY, Virginia Polytechnic Institute and State University; L. RIDGWAY SCOTT, University of Chicago; MIKHAIL SHASHKOV, Los Alamos National Laboratory; CHRISTINE A. SHOEMAKER, Cornell University; VALERIA SIMONCINI, Università di Bologna; ZDENEK STRAKOS, Charles University in Prague; BERND STURMFELS, University of California Berkeley; JORGE X. VELASCO-HERNANDEZ, Universidad Nacional Autónoma de Mexico; MICHAEL S. VOGELIUS, Rutgers, The State University of New Jersey.

—From a SIAM announcement

American Academy of Arts and Sciences Elections

The American Academy of Arts and Sciences has elected 204 new fellows and 16 foreign honorary members for 2014. Following are the new fellows whose work involves the mathematical sciences:

DEBORAH LOEWENBERG BALL, University of Michigan; MICHAEL P. BRENNER, Harvard University; EMMANUEL J. CANDÈS, Stanford University; JENNIFER T. CHAYES, Microsoft Research New England; EDWARD FRENKEL, University of California Berkeley; DAVID GABAI, Princeton University; RICHARD W. KENYON, Brown University; DAPHNE KOLLER, Stanford University; LESLIE B. LAMPORT, Microsoft Research; RICHARD J. LIPTON, Georgia Institute of Technology; PAUL A. SEIDEL, Massachusetts Institute of Technology; GIGLIOLA STAFFILANI, Massachusetts Institute of Technology; and DANIEL I. TĂTARU, University of California Berkeley. MICHEL BROUÉ of Université Paris Diderot was elected as a foreign honorary member.

—From an AAAS announcement

Isidore Fleischer (1927–2011)

ISIDORE (IZZY) FLEISCHER was born to Abraham and Augusta Fleischer (née Lipper) in June of 1927 in Leipzig, Germany. Isidore was registered as a U.S. citizen in the same year with the American Consulate in Leipzig because Abraham had become a naturalized American citizen in 1922, his work as a diamond cutter and trader frequently taking him between New York and Europe. Unable to continue working under the Nazi regime, Abraham returned to the United States. Augusta sailed with Isidore and his sister, Sarah, to New York in 1934 to rejoin Abraham.

Isidore grew up in Brooklyn and served briefly in the U.S. Navy at the end of World War II. Following the war he attended Brooklyn College in New York and then did graduate work at the University of Chicago, graduating in 1952 as Irving Kaplansky's first Ph.D. student, along with another Kaplansky student, Arlen Brown. His thesis topic was algebraic treatment of locally symmetric topological spaces. Isidore did postdoctoral studies with Laurent Schwartz in Paris and subsequently taught for one or two years in southern France. Returning to the United States, he taught at Purdue until he was dismissed in 1961 because he refused to sign a loyalty oath in the wake of the infamous McCarthy era. He spent the remainder of his career as a visitor to many universities throughout the world, surviving financially as best he could using a bequest from his father and support from colleagues. In particular, he spent much time in the Centre de Recherche Mathématiques at the Université de Montréal.

His earliest paper dealt with topological fields with valuation and appeared in *Comptes Rendus de l'Académie des Sciences* in 1953. He subsequently generalized it to topological division rings and then turned to non-Archimedean normed spaces. Isidore was also deeply interested in universal algebra, and in 1955, generalizing a result of Fuchs, Isidore gave a sufficient condition for a subalgebra of the direct product $B_1 \times B_2$ of algebras B_1 and B_2 to be the equalizer of two homomorphisms with domains B_1 and B_2, respectively. This result is mentioned in several universal algebra texts as "Fleischer's Lemma". Taking a lattice-theoretic approach in a 1956 paper in the *Annals of Mathematics*, Isidore extended Ky Fan's characterization of the set of continuous real-valued functions on a compact Hausdorff space as a partially ordered group. In the next year he published another paper in the *Annals* giving decomposition theorems for modules over Prüfer rings. He continued to publish while working for Sylvania Applied Research Laboratory and at Bell Labs in the late 1950s. Over the years, Isidore worked with many collaborators until his death in 2011, producing well over one hundred papers in such diverse areas as universal algebra, lattice and semigroup theory, general topology, convergence spaces, logic, category theory, group-valued measures, stochastic processes, and ordered groups. Isidore espoused a compressed style of mathematical writing, which created tension with his coauthors, delayed publication of some of his papers, and did not win him many friends among his referees!

Isidore was a member of the AMS for twenty-six years and became a member of the Fiske Society, whose members have included the AMS in their estate plans. Isidore left the entirety of his estate to the AMS.

Note. I am indebted to Lucienne Cummings, Syd Bulman-Fleming, and Tim Traynor for information about Isidore. Reprints of many of his papers may be obtained by sending email to Tim Traynor at `tt@uwindsor.ca`.

—Larry Cummings
University of Waterloo

Mathematics Opportunities

NSF CAREER Awards

The National Science Foundation (NSF) solicits proposals for the Faculty Early Career Development (CAREER) Awards. These awards support junior faculty members who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations. In addition, award recipients are eligible to be selected for Presidential Early Career Awards for Scientists and Engineers (PECASE). The deadline for submission of proposals in the mathematical sciences is **July 23, 2014**. For more information see http://www.nsf.gov/pubs/2014/nsf14532/nsf14532.htm.

—From an NSF announcement

Call for Nominations for Parzen Prize

To promote the dissemination of statistical innovation, the Emanuel and Carol Parzen Prize for Statistical Innovation is awarded in even-numbered years to a North American statistician whose outstanding research contributions include innovations that have had an impact on practice and who received his or her Ph.D. degree at least twenty-five years before the nomination.

The Parzen Prize is awarded by the Department of Statistics at Texas A&M and consists of an honorarium of US$1,000 and travel expenses to College Station, Texas, to present a lecture at the prize ceremony. Nominations for the 2014 Parzen Prize should be submitted by **August 15, 2014**, to Thomas Wehrly, Department of Statistics, Texas A&M University, TAMU 3143, College Station, Texas 77843-3143. For more information see the website http://www.stat.tamu.edu/events/parzenprize/index.html.

—From a Texas A&M announcement

Call for Nominations for Heineman Prize

The American Physical Society (APS) and the American Institute of Physics (AIP) are seeking nominations for the 2015 Dannie Heineman Prize for Mathematical Physics. The prize recognizes outstanding publications in the field of mathematical physics. The prize carries a cash award of US$10,000, an award certificate, and travel expenses to the meeting at which the prize is given. The deadline for nominations for the 2015 prize is **July 1, 2014**. For more information see the APS website at http://www.aps.org/programs/honors/prizes/heineman.cfm.

—From an APS announcement

Call for Nominations for the 2014 SASTRA Ramanujan Prize

The Shanmugha Arts, Science, Technology, Research Academy (SASTRA) is seeking nominations for the 2014 SASTRA Ramanujan Prize. The prize is given annually to a mathematician not over the age of thirty-two for outstanding contributions in an area of mathematics influenced by the late Indian mathematical genius Srinivasa Ramanujan. The prize carries a cash award of US$10,000 and an invitation to give a talk at the SASTRA conference in December 2014. The deadline for nominations is **July 31, 2014**. For more information see the website http://qseries.org/sastra-prize/nominations-2014.html.

—Krishna Alladi, University of Florida

Call for Nominations for Sloan Fellowships

Nominations of candidates for Sloan Research Fellowships, sponsored by the Alfred P. Sloan Foundation, are due by **September 15, 2014**. A candidate must be a member of the regular faculty at a college or university in the United States or Canada and must have received the Ph.D. or equivalent within the six years prior to the nomination. For information write to: Sloan Research Fellowships, Alfred P. Sloan Foundation, 630 Fifth Avenue, Suite 2550, New York, New York 10111-0242, or consult the foundation's website: http://www.sloan.org/fellowships.

—From a Sloan Foundation announcement

Fulbright Postdoctoral Fellowships in Israel

The United States-Israel Educational Foundation (USIEF), the Fulbright commission for Israel, will award eight fellowships to U.S. postdoctoral researchers in support of work to be carried out at Israeli universities during the course of the 2015–2016 academic year. The fellowships will support study for at least two academic years with an award of US$20,000

per academic year. The deadline for applications is **August 1, 2014**. For more information see the website http://fulbright.org.il/en/?pageid=1024&utm_source=AmericanMathematicalSociety&utm_medium=www&utm_campaign=postdoc.

—From a USIEF announcement

News from the Clay Mathematics Institute

The Clay Mathematics Institute (CMI) will hold the 2014 Clay Research Conference on October 1, 2014, at the Mathematical Institute of the University of Oxford. The speakers are Ben Green (University of Oxford), Jonathan Pila (University of Oxford), Paul Seidel (Massachusetts Institute of Technology), and Scott Sheffield (Massachusetts Institute of Technology).

The recipient of the 2014 Clay Research Award will be announced at the conference. Presented annually, the Clay Research Award celebrates outstanding achievements in mathematical research.

The following workshops will be held throughout the week of the conference:

September 28–October 2, 2014: Advances in Probability. Ivan Corwin and Martin Hairer.

September 29–October 3, 2014: Analytic Number Theory. Ben Green and Roger Heath-Brown.

September 29–October 3, 2014: Functional Transcendence around Ax-Schanuel. Jonathan Pila and Alex Wilkie.

September 29–October 3, 2014: Symplectic Topology. Dominic Joyce, Alexander Ritter, and Ivan Smith.

Registration for the Clay Research Conference is free and required. Participation in the workshops is by invitation; a limited number of additional places are available. Limited accommodation is available for Ph.D. students and early-career researchers. For more information email Naomi Kraker at admin@claymath.org. For full details, including the schedule, titles, and abstracts when they become available, see www.claymath.org.

—From a CMI announcement

News from IPAM

The Institute for Pure and Applied Mathematics (IPAM) offers programs that encourage collaboration across disciplines and between two areas of mathematics. IPAM holds long programs (three months) and workshops (three to five days) throughout the academic year for junior and senior mathematicians and scientists who work in academia, the national laboratories, and industry.

In the summer, IPAM offers an industrial research experience for undergraduates and a summer school for graduate students and postdocs. IPAM seeks program proposals from the math and science communities. Please send your idea for a workshop, long program, or summer school to director@ipam.ucla.edu.

IPAM will host the Blackwell-Tapia Conference and Awards Ceremony on November 14–15, 2014. This biennial conference was established in 2002 in honor of David H. Blackwell and Richard A. Tapia, distinguished mathematical scientists who have been inspirations to more than a generation of African American and Latino/Latina students and professionals in the mathematical sciences. The 2014 Blackwell-Tapia Prize will be presented at the conference. More information and an application are available on IPAM's website. The application deadline is **September 15, 2014**.

Additionally, IPAM will host the Latinos in Mathematics Conference April 9–11, 2015. The conference will feature talks by several prominent Latino/Latina mathematicians and statisticians. It will also include mentoring and networking activities and opportunities for students to present their research. Please check the IPAM website in the fall for information.

Following is a list of upcoming programs at IPAM. Please see the website www.ipam.ucla.edu for detailed information and to find application and registration forms.

September 8–December 12, 2014: Mathematics of Turbulence. You may apply online for support to be a core participant for the entire program or to attend any of the following individual workshops.

September 9–12, 2014: Tutorials.

September 29–October 3, 2014: Workshop I: Mathematical Analysis of Turbulence.

October 13–17, 2014: Workshop II: Turbulent Transport and Mixing.

October 27–31, 2014: Workshop III: Geophysical and Astrophysical Turbulence.

November 17–21, 2014: Workshop IV: Turbulence in Engineering Applications.

Winter Workshops. You may apply for support or register for each workshop online.

January 12–16, 2015: Multiple Sequence Alignment.

January 26–30, 2015: Symmetry and Topology in Quantum Matter.

February 4–6, 2015: Computational Photography and Intelligent Cameras.

February 9–13, 2015: Zariski-Dense Subgroups.

February 23–27, 2015: Machine Learning for Many-Particle Systems.

March 9–June 12, 2015: Broad Perspectives and New Directions in Financial Mathematics. You may apply online for support to be a core participant for the entire program or to attend any of the following individual workshops.

March 10–13, 2015: Tutorials.

March 23–27, 2015: Workshop I: Systemic Risk and the Financial Networks.

April 13–17, 2015: Workshop II: The Mathematics of High Frequency Financial Markets.

May 4–8, 2015: Workshop III: Commodity Markets and Their Financialization.

May 18–22, 2015: Workshop IV: Forensic Analysis of Financial Data.

September 8–December 11, 2015: New Directions in Mathematical Approaches for Traffic Flow Management. You may apply online for support to be a core participant

for the entire program or to attend any of the following individual workshops.

September 9–12, 2015: Tutorials.

September 28–October 2, 2015: Workshop I: Mathematical Foundations of Traffic.

October 12–16, 2015: Workshop II: Traffic Estimation.

October 26–30, 2015: Workshop III: Traffic Control.

November 16–20, 2015: Workshop IV: Decision Support for Traffic.

March 7–June 10, 2016: Culture Analytics. You may apply online for support to be a core participant for the entire program or to attend any of the individual workshops. The workshop schedule will be posted soon.

—From an IPAM announcement

News from MSRI

With funding from the National Science Foundation (NSF), the National Security Agency (NSA), and the Clay Mathematics Institute (CMI), the Mathematical Sciences Research Institute (MSRI) will hold six workshops in Geometric Representation Theory and New Geometric Methods in Number Theory and Automorphic Forms during the fall of 2014. Established researchers, postdoctoral fellows, and graduate students are invited to apply for funding. It is the policy of MSRI to actively seek to achieve diversity in its workshops. Thus a strong effort is made to remove barriers that hinder equal opportunity, particularly for those groups that have been historically underrepresented in the mathematical sciences. MSRI is proud to announce a new resource to assist visitors with finding child care in Berkeley. For more information, please contact Sanjani Varkey at sanjani@msri.org.

The workshops are as follows:

August 14–15, 2014: Connections for Women: New Geometric Methods in Number Theory and Automorphic Forms. Website: http://www.msri.org/workshops/709.

August 18–22, 2014: Introductory Workshop: New Geometric Methods in Number Theory and Automorphic Forms. Website: http://www.msri.org/workshops/710.

August 28–29, 2014: Connections for Women: Geometric Representation Theory. Website: http://www.msri.org/workshops/706.

September 2–5, 2014: Introductory Workshop: Geometric Representation Theory. Website: http://www.msri.org/workshops/707.

November 17–21, 2014: Categorical Structures in Harmonic Analysis. Website: http://www.msri.org/workshops/708.

December 1–5, 2014: Automorphic Forms, Shimura Varieties, Galois Representations, and *L*-functions. Website: http://www.msri.org/workshops/719.

—From an MSRI announcement

Inside the AMS

Fan China Exchange Program Awardees

The Society's Fan China Exchange Program awards grants to support collaborations between Chinese and U.S. or Canadian researchers. Institutions in the United States or Canada apply for the funds to support a visitor from China or vice versa. This funding is made possible through a generous gift made to the AMS by Ky and Yu-Fen Fan in 1999. The awardees for 2014 follow.

Auburn University received a grant of US$3,600 to support a visit from Hongtao Zhao of North China Electric Power University.

Inner Mongolia University received a grant of US$5,000 to support a visit from Anton Zettl of Northern Illinois University.

Each visitor's own department will receive a grant of US$1,000 after the visit.

For information about the Fan China Exchange Program, visit the website http://www.ams.org/programs/travel-grants/china-exchange/china-exchange or contact the AMS Membership and Programs Department, email: chinaexchange@ams.org, telephone 401-455-4170 (within the U.S. call 800-321-4267, ext. 4170).

—AMS Membership and Programs Department

Erdős Memorial Lecture

The Erdős Memorial Lecture is an annual invited address named for the prolific mathematician Paul Erdős (1913–1996). The lectures are supported by a fund created by Andrew Beal, a Dallas banker and mathematics enthusiast. The Beal Prize Fund, now US$100,000, is being held by the AMS until it is awarded for a correct solution to the Beal Conjecture (see www.math.unt.edu/~mauldin/beal.html). At Mr. Beal's request, the interest from the fund is used to support the Erdős Memorial Lecture.

The Erdős Memorial Lecturer for 2014 was Maria Chudnovsky of Columbia University. She gave a talk in March 2013 titled "Coloring Graphs with Forbidden Induced Subgraphs" at the spring southeastern sectional meeting at the University of Knoxville, Tennessee.

—AMS announcement

From the AMS Public Awareness Office

Math in the Media. Tony Phillips and past AMS-AAAS Mass Media Fellows write their takes and summaries on recent media coverage of mathematics and mathematicians. Explore the archive to read about Edward Frenkel on *The Colbert Report*; mathematics and March Madness; what's new at MoMath; the perception of mathematical beauty; Nate Silver and FiveThirtyEight; and to see links to reviews of "The Simpsons and Their Mathematical Secrets" by Simon Singh and "Undiluted Hocus-Pocus: The Autobiography of Martin Gardner" by Martin Gardner. http://www.ams.org/mathmedia/.

—Annette Emerson and Mike Breen
AMS Public Awareness Officers
paoffice@ams.org

Deaths of AMS Members

JAMES BADENIUS, of Sumner, Washington, died on February 22, 2014. Born on June 8, 1928, he was a member of the Society for 20 years.

JOHN A. HIGGINS, of Middletown, Delaware, died on October 30, 2013. Born on September 23, 1942, he was a member of the Society for 41 years.

WILLIAM C. HOFFMAN, of Tucson, Arizona, died on January 16, 2013. Born on August 11, 1919, he was a member of the Society for 66 years.

JUN-ICHI IGUSA, of Hunt Valley, Maryland, died on November 24, 2013. Born on January 30, 1924, he was a member of the Society for 56 years.

ARLEN M. ILIN, professor, Russian Academy of Sciences, Institute of Mathematics and Mechanics, died on June 23, 2013. Born on January 8, 1932, Professor Ilin was a member of the Society for 20 years.

THOMAS C. KIPPS, of Fresno, California, died on March 10, 2014. Born on February 28, 1923, he was a member of the Society for 58 years.

CLINTON J. KOLASKI, of Superior, Wisconsin, died on April 18, 2012. Born on October 30, 1938, he was a member of the Society for 38 years.

RICHARD LAVER, professor, University of Colorado, died on September 19, 2012. Born on October 20, 1942, he was a member of the Society for 26 years.

P. J. LELONG, of Paris, France, died on October 12, 2011. Born on March 14, 1912, he was a member of the Society for 62 years.

GARY B. LEVY, of Metairie, Louisiana, died on January 15, 2013. Born on October 21, 1941, he was a member of the Society for 42 years.

LAWRENCE S. LEVY, of Madison, Wisconsin, died on March 22, 2014. Born on October 21, 1933, he was a member of the Society for 54 years.

LEE LORCH, professor, York University, died on February 28, 2014. Born on September 20, 1915, he was a member of the Society for 77 years.

ANN ROBERTSON, professor, Connecticut College, died on November 20, 2013. Born on March 19, 1943, she was a member of the Society for 36 years.

W. C. ROYSTER, professor, University of Kentucky, died on February 19, 2014. Born on January 12, 1925, he was a member of the Society for 61 years.

WILLIAM H. RUCKLE, of Seneca, South Carolina, died on February 26, 2014. Born on October 29, 1936, he was a member of the Society for 52 years.

VICTOR L. SHAPIRO, professor, University of California Riverside, died on March 1, 2013. Born on October 16, 1924, he was a member of the Society for 61 years.

RICHARD F. THOMPSON, of Waldorf, Maryland, died on March 12, 2013. Born on May 29, 1931, he was a member of the Society for 14 years.

JERZY URBANOWICZ, professor, Polish Academy of Science, Poland, died on September 6, 2012. Born on May 28, 1951, he was a member of the Society for 20 years.

JOE F. WAMPLER, of Lincoln, Nebraska, died on December 19, 2013. Born on December 13, 1926, he was a member of the Society for 31 years.

GERALD B. WHITHAM, professor, California Institute of Technology, died on January 26, 2014. Born on December 13, 1927, he was a member of the Society for 32 years.

Reference and Book List

*The **Reference** section of the* Notices *is intended to provide the reader with frequently sought information in an easily accessible manner. New information is printed as it becomes available and is referenced after the first printing. As soon as information is updated or otherwise changed, it will be noted in this section.*

Contacting the *Notices*

The preferred method for contacting the *Notices* is electronic mail. The editor is the person to whom to send articles and letters for consideration. Articles include feature articles, memorial articles, communications, opinion pieces, and book reviews. The editor is also the person to whom to send news of unusual interest about other people's mathematics research.

The managing editor is the person to whom to send items for "Mathematics People", "Mathematics Opportunities", "For Your Information", "Reference and Book List", and "Mathematics Calendar". Requests for permissions, as well as all other inquiries, go to the managing editor.

The electronic-mail addresses are `notices@math.wustl.edu` in the case of the editor and `smf@ams.org` in the case of the managing editor. The fax numbers are 314-935-6839 for the editor and 401-331-3842 for the managing editor. Postal addresses may be found in the masthead.

Information for *Notices* Authors

The *Notices* welcomes unsolicited articles for consideration for publication, as well as proposals for such articles. The following provides general guidelines for writing *Notices* articles and preparing them for submission. Contact information for *Notices* editors and staff may be found on the *Notices* website, `http://www.ams.org/notices`.

***Notices* readership**. The *Notices* publishes articles that have broad appeal for a diverse audience with many different types of readers: graduate students, academic mathematicians, industrial mathematicians, researchers in mathematically based fields, and amateur enthusiasts. The paper edition of the *Notices* is sent to the approximately 33,000 members of the AMS, most of whom are professional mathematicians; about 25,000 of them reside in North America. Because the *Notices* is accessible for free over the Internet, the number of readers is much larger than the AMS membership. All readers may be assumed to be interested in mathematics research, but they are not all active researchers.

Notices Feature Articles

Topics. The *Notices* seeks exceptional articles that report on major new developments in mathematics or that describe episodes from mathematics history that have connection to current research in the field. We also welcome articles discussing aspects of the mathematics profession, such as grant programs, the job market, professional opportunities for mathematicians, publishing, electronic communications, etc. We are also interested in articles about mathematics education at all levels. We publish reviews of books, films, plays, software, and mathematical tools.

Reaching the audience. Our goal is to educate the readership about new developments in mathematics and in the mathematics profession, as well as other matters of interest to the working mathematician. Each article is expected to have a large target audience of readers, perhaps 5,000 of the 33,000 subscribers. Authors must therefore write their articles for nonexperts rather than for experts or would-be experts. In particular, the mathematics articles in the *Notices* are expository. A *Notices* article should have an introduction that anyone can understand, and almost all readers

Where to Find It

A brief index to information that appears in this and previous issues of the *Notices*.

should be able to understand the key points of the article.

Structure of articles. Most feature articles, including those on mathematics, are expected to be of long-term value and should be written as such. Ideally each article should put its topic in a context, providing some history and other orientation for the reader, and, as necessary, relating the subject matter to things that readers are likely to understand. In most cases, articles should progress to dealing with contemporary matters, not giving only historical material. The articles that are received the best by readers tend to relate different areas of mathematics to each other.

By design the *Notices* is partly magazine and partly journal, and authors' expository styles should take this into account. For example, many readers want to understand the mathematics articles without undue effort and without consulting other sources.

Format and length. Mathematics feature articles in the *Notices* are normally six to nine pages, sometimes a little longer. Shorter articles are more likely to be read fully than are longer articles. The first page is 400 or 500 words, and subsequent pages are about 800 words. From this one should subtract an allowance for figures, photos, and other illustrations and an appropriate allowance for any displayed equations and bibliography. The *Notices* is especially interested in the creative use of graphics and color and encourages illustrations. Articles on professional topics are typically 3 to 5 pages, as are book reviews.

Editorial process. The *Notices* aims to publish exceptionally well-written articles that appeal to a broad audience of mathematicians. Highly technical, specialized articles with a great deal of notation, insider jargon, and a long list of references are not suitable for the *Notices*. Some articles will be rejected by the editors without any external review. Other articles will be carefully refereed, and then a detailed editorial process will be used to bring the article up to the *Notices* standard. There will be considerable give and take between the author(s) and the editor, and it may take several drafts to get the article right.

The "WHAT IS...?" Column

Nearly every issue of the *Notices* carries an installment of the "WHAT IS...?" column. The purpose of the column is to provide brief, nontechnical descriptions of mathematical objects in use in current research. The target audience for the columns is first-year graduate students.

Each "WHAT IS...?" column provides an expository description of a single mathematical object being used in contemporary research. Thus "WHAT IS *M*-Theory?" would be too broad, but "WHAT IS a Brane?" would be appropriate; ideally "WHAT IS a Brane?" would give a flavor of what *M*-theory is.

The writing should be nontechnical and informal. Narrative description conveying main ideas should be favored over notation-heavy precision.

There is a limit of two *Notices* pages (1,400 words with no picture or 1,200 words with one picture). A list of "Further Reading" should contain no more than three references. Inquiries and comments about the "WHAT IS...?" column are welcome and may be sent to notices-whatis@ams.org.

Upcoming Deadlines

July 1, 2014: Nominations for the 2015 Dannie Heineman Prize for Mathematical Physics. See "Mathematic Opportunities" in this issue.

July 20, 2014: Applications for New York City Master Teacher Fellowships of Math for America (MfA). See http://www.mathforamerica.org/web/guest/apply.

July 23, 2014: Proposals for NSF CAREER Awards. See "Mathematics Opportunities" in this issue.

July 31, 2014: Nominations for 2014 SASTRA Ramanujan Prize. See "Mathematics Opportunities" in this issue.

August 1, 2014: Applications for United States-Israel Foundation (USIEF) Fulbright Postdoctoral Fellowships. See "Mathematics Opportunities" in this issue.

August 1, 2014: Applications for August review for National Academies Research Associateship Programs. See http://sites.nationalacademies.org/PGA/RAP/PGA_050491 or contact Research Associateship Programs, National Research Council, Keck 568, 500 Fifth Street, NW, Washington, DC 20001; telephone 202-334-2760; fax 202-334-2759; email rap@nas.edu.

August 12, 2014: Full proposals for NSF Scholarships in Science, Technology, Engineering, and Mathematics (STEM). See http://www.nsf.gov/pubs/2012/nsf12529/nsf12529.htm.

August 15, 2014: Nominations for the 2014 Parzen Prize. See "Mathematics Opportunities" in this issue.

September 15, 2014: Nominations for Alfred P. Sloan Foundation Research Fellowships. See "Mathematics Opportunities" in this issue.

September 15, 2014: Applications for Blackwell-Tapia Conference at IPAM. See "Mathematics Opportunities" in this issue.

September 15, 2014: Applications for spring 2015 semester of Math in Moscow. See http://www.mccme.ru/mathinmoscow or contact: Math in Moscow, P.O. Box 524, Wynnewood, PA 19096; fax: +7095-291-65-01; email: mim@mccme.ru. Information and application forms for the AMS scholarships are available on the AMS website at http://www.ams.org/programs/travel-grants/mimoscow, or contact: Math in Moscow Program, Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence RI 02904-2294; email student-serv@ams.org.

October 1, 2014: Applications for AWM Travel Grants and Mathematics Education Research Travel Grants. See https://sites.google.com/site/awmmath/programs/travel-grants; telephone: 703-934-0163; or email: awm@awm-math.org; or contact Association for Women in Mathematics, 11240 Waples Mill Road, Suite 200, Fairfax, VA 22030.

October 15, 2014: Proposals for NSF Postdoctoral Research Fellowships. See http://www.nsf.gov/pubs/2012/nsf12496/nsf12496.htm.

November 1, 2014: Applications for November review for National

Academies Research Associateship Programs. See the website http://sites.nationalacademies.org/PGA/RAP/PGA_050491 or contact Research Associateship Programs, National Research Council, Keck 568, 500 Fifth Street, NW, Washington, DC 20001; telephone 202-334-2760; fax 202-334-2759; email rap@nas.edu.

Book List

The Book List highlights recent books that have mathematical themes and are aimed at a broad audience potentially including mathematicians, students, and the general public. Suggestions for books to include on the list may be sent to notices-booklist@ams.org.

*Added to "Book List" since the list's last appearance.

Alan M. Turing: Centenary Edition, by Sara Turing. Cambridge University Press, April 2012. ISBN-13: 978-11070-205-80.

Alan Turing: The Enigma, The Centenary Edition, by Andrew Hodges. Princeton University Press, May 2012. ISBN-13: 978-06911-556-47.

Alan Turing: His Work and Impact, edited by S. Barry Cooper and J. van Leeuwen. Elsevier, May 2013. ISBN-13: 978-01238-698-07.

Alan Turing's Electronic Brain: The Struggle to Build the ACE, the World's Fastest Computer, by B. Jack Copeland et al. Oxford University Press, May 2012. ISBN-13: 978-0-19-960915-4.

Algorithms Unlocked, by Thomas H. Cormen. MIT Press, March 2013. ISBN-13: 978-02625-188-02.

An Accidental Statistician: The Life and Memories of George E. P. Box, by George E. P. Box. Wiley, April 2013. ISBN-13: 978-1-118-40088-3.

A Cabinet of Mathematical Curiosities at Teachers College: David Eugene Smith's Collection, by Diane R. Murray. Docent Press, November 2013. ISBN-13: 978-0-9887449-1-2.

A Calculus of Ideas: A Mathematical Study of Human Thought, by Ulf Grenander. World Scientific, September 2012. ISBN-13: 978-98143-831-89. (Reviewed January 2014.)

Classic Problems of Probability, by Prakash Gorroochurn. Wiley, May 2012. ISBN-13: 978-1-1180-6325-5. (Reviewed November 2013.)

**Circles Disturbed. The Interplay of Mathematics and Narrative,* edited by Apostolos Doxiadis and Barry Mazur. Princeton University Press, March 2012. ISBN: 978-06911490-42.

Computability: Turing, Gödel, Church, and Beyond, edited by B. Jack Copeland, Carl J. Posy, and Oron Shagrir. MIT Press, June 2013. ISBN-13: 978-02620-189-99.

Do I Count?: Stories from Mathematics, by Günter Ziegler (translation of *Darf ich Zahlen?: Geschichte aus der Mathematik,* Piper Verlag, 2010). CRC Press/A K Peters, July 2013. ISBN-13: 978-1466564916

Enlightening Symbols: A Short History of Mathematical Notation and Its Hidden Powers, by Joseph Mazur. Princeton University Press, March 2014. ISBN-13: 978-06911-546-33.

Four Lives: A Celebration of Raymond Smullyan, edited by Jason Rosenhouse. Dover Publications, February 2014. ISBN-13: 978-04864-906-70.

Fractals: A Very Short Introduction, by Kenneth Falconer. Oxford University Press, December 2013. ISBN-13: 978-01996-759-82.

The Gödelian Puzzle Book: Puzzles, Paradoxes and Proofs, by Raymond M. Smullyan. Dover Publications, August 2013. ISBN-13: 978-04864-970-51.

Good Math: A Geek's Guide to the Beauty of Numbers, Logic, and Computation, by Mark C. Chu-Carroll. Pragmatic Bookshelf, July 2013. ISBN-13: 978-19377-853-38.

Henri Poincaré: A Scientific Biography, by Jeremy Gray. Princeton University Press, November 2012. ISBN-13: 978-06911-527-14. (Reviewed April 2014.)

**A History in Sum: 150 Years of Mathematics at Harvard (1825–1975),* by Steve Nadis and Shing-Tung Yau. Harvard University Press, October 2013. ISBN-13:978-06747-250-03. (Reviewed in this issue.)

**How Not to Be Wrong: The Power of Mathematical Thinking,* by Jordan Ellenberg. Penguin Press, June 2014. ISBN-13: 978-15942-052-24. I

If A, Then B: How the World Discovered Logic, by Michael Shenefelt and Heidi White. Columbia University Press, June 2013. ISBN-13:978-02311-610-53.

Imagined Civilizations: China, the West, and Their First Encounter, by Roger Hart. Johns Hopkins University Press, July 2013. ISBN-13:978-14214-060-60.

The Improbability Principle: Why Coincidences, Miracles, and Rare Events Happen Every Day, by David J. Hand. Scientific American/Farrar, Straus and Giroux, February 2014. ISBN-13: *978-03741-753-44.*

**Infinitesimal: How a Dangerous Mathematical Theory Shaped the Modern World,* by Amir Alexander. Scientific American/Farrar, Straus and Giroux, April 2014. ISBN-13: 978-03741-768-15.

Invisible in the Storm: The Role of Mathematics in Understanding Weather, by Ian Roulstone and John Norbury. Princeton University Press, February 2013. ISBN-13: 978-06911-527-21. (Reviewed September 2013.)

**L. E. J. Brouwer—Topologist, Intuitionist, Philosopher: How Mathematics Is Rooted in Life,* by Dirk van Dalen. Springer (2013 edition), December 2012. ISBN-13: 978-14471-461-55. (Reviewed in this issue.)

Jane Austen, Game Theorist, by Michael Suk-Young Chwe. Princeton University Press, April 2013. ISBN-13: 978-06911-557-60.

The Logic of Infinity, by Barnaby Sheppard Cambridge University Press, May 2014. ISBN-13: 978-11076-786-68.

The Logician and the Engineer: How George Boole and Claude Shannon Created the Information Age, by Paul J. Nahin, Princeton University Press, October 2012. ISBN-13: 978-06911-510-07. (Reviewed October 2013.)

Love and Math: The Heart of Hidden Reality, by Edward Frenkel. Basic Books, October 2013. ISBN-13: 978-04650-507-41.

Magnificent Mistakes in Mathematics, by Alfred S. Posamentier and Ingmar Lehmann. Prometheus Books, August 2013. ISBN-13: 978-16161-474-71.

The Math Book: From Pythagoras to the 57th Dimension, 250 Milestones in the History of Mathematics, by Clifford A. Pickover. Sterling. February, 2012. ISBN-13: 978-14027-882-91.

Mathematics: An Illustrated History of Numbers, edited by Tom Jackson.

Shelter Harbor Press, October 2012. ISBN-13: 978-09853-230-42.

Mathematics in Nineteenth-Century America: The Bowditch Generation, by Todd Timmons. Docent Press, July 2013. ISBN-13: 978-0-9887449-3-6.

Mathematics of the Transcendental, by Alain Badiou (translated by A. J. Bartlett and Alex Ling). Bloomsbury Academic, March 2014. ISBN-13: 978-14411-892-40.

**Math Bytes: Google Bombs, Chocolate-Covered Pi, and Other Cool Bits in Computing,* by Tim Chartier. Princeton University Press, April 2014. ISBN-13: 978-06911-606-03.

Math in Minutes: 200 Key Concepts Explained in an Instant, by Paul Glendinning. Quercus, September 2013. ISBN-13: 978-16236-500-87.

Math in 100 Key Breakthroughs, by Richard Elwes. Quercus, December 2013. ISBN-13: 978-16236-505-44.

Math Is Murder, by Robert C. Brigham. iUniverse, March, 2012. ISBN-13 978-14697-972-81.

Math on Trial: How Numbers Get Used and Abused in the Courtroom, by Leila Schneps and Coralie Colmez. Basic Books, March 2013. ISBN-13: 978-04650-329-21. (Reviewed August 2013.)

My Brief History, by Stephen Hawking. Bantam Dell, September 2013. ISBN-13: 978-03455-352-83.

Naked Statistics: Stripping the Dread from the Data, by Charles Wheelan. W. W. Norton & Company, January 2013. ISBN-13: 978-03930-719-55.

Naming Infinity: A True Story of Religious Mysticism and Mathematical Creativity, by Loren Graham and Jean-Michel Kantor. Belknap Press of Harvard University Press, March 2009. ISBN-13: 978-06740-329-34. (Reviewed January 2014.)

The New York Times Book of Mathematics: More Than 100 Years of Writing by the Numbers, edited by Gina Kolata. Sterling, June 2013. ISBN-13: 978-14027-932-26. (Reviewed May 2014.)

The Noether Theorems: Invariance and Conservation Laws in the Twentieth Century, by Yvette Kosmann-Schwarzbach. Springer, December 2010. ISBN-13: 978-03878-786-76. (Reviewed August 2013.)

**Numbers Are Forever,* by Liz Strachan. Constable, March 2014. ISBN-13: 978-14721-110-43.

Our Mathematical Universe: My Quest for the Ultimate Nature of Reality, by Max Tegmark. Knopf, January 2014. ISBN-13: 978-03075-998-03.

The Outer Limits of Reason: What Science, Mathematics, and Logic Cannot Tell Us, by Noson S. Yanofsky. MIT Press, August 2013. ISBN-13: 978-02620-193-54.

Perfect Mechanics: Instrument Makers at the Royal Society of London in the Eighteenth Century, by Richard Sorrenson. Docent Press, September 2013. ISBN-13: 978-0-9887449-2-9.

**The Perfect Theory: A Century of Geniuses and the Battle over General Relativity,* by Pedro G. Ferreira. Houghton Mifflin Harcourt, February 2014. ISBN-13: 978-05475-548-91.

Philosophy of Mathematics in the Twentieth Century, by Charles Parsons. Harvard University Press, March 2014. ISBN-13: 978-06747-280-66.

Probably Approximately Correct: Nature's Algorithms for Learning and Prospering in a Complex World, by Leslie Valiant. Basic Books, June 2013. ISBN-13: 978-04650-327-16.

Quantum Computing since Democritus, by Scott Aaronson. Cambridge University Press, March 2013. ISBN-13: 978-05211-995-68.

The Simpsons and Their Mathematical Secrets, by Simon Singh. Bloomsbury, October 2013. ISBN-13: 978-14088-353-02.

Sources in the Development of Mathematics: Series and Products from the Fifteenth to the Twenty-first Century, by Ranjan Roy. Cambridge University Press, June 2011. ISBN-13: 978-05211-147-07. (Reviewed November 2013.)

Strange Attractors (comic book), by Charles Soule, Greg Scott, and Robert Saywitz. Archaia Entertainment, May 2013. ISBN-13: 978-19363-936-26.

Symmetry: A Very Short Introduction, by Ian Stewart. Oxford University Press, July 2013. ISBN-13: 978-01996-519-86.

A Tale of Two Fractals, by A. A. Kirillov. Birkhäuser, May 2013. ISBN-13: 978-08176-838-18.

Théorème vivant, by Cédric Villani (in French). Grasset et Fasquelle, August 2012. ISBN-13: 978-2246798828. (Reviewed February 2014.)

Turing: Pioneer of the Information Age, by Jack Copeland. Oxford University Press, January 2013. ISBN-13: 978-01996-397-93.

Turing's Cathedral: The Origins of the Digital Universe, by George Dyson. Pantheon/Vintage, December 2012. ISBN-13: 978-14000-759-97.

Undiluted Hocus-Pocus: The Autobiography of Martin Gardner. Princeton University Press, September 2013. ISBN-13: 978-06911-599-11. (Reviewed March 2014.)

Why Is There Philosophy of Mathematics At All?, by Ian Hacking. Cambridge University Press, April 2014. ISBN-13: 978-11070-501-74.

William Fogg Osgood at Harvard: Agent of a Transformation of Mathematics in the United States, by Diann R. Porter. Docent Press, November 2013. ISBN-13: 978-0-9887449-4-3.

Governance of the Society 2014

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Mathematics Calendar

Please submit conference information for the Mathematics Calendar through the Mathematics Calendar submission form at http://www.ams.org/cgi-bin/mathcal-submit.pl. The most comprehensive and up-to-date Mathematics Calendar information is available on the AMS website at http://www.ams.org/mathcal/.

June 2014

1–7 **Modern Time-Frequency Analysis**, Strobl, Austria. (Apr. 2013, p. 429)

2–5 **WSCG 2014 - 22nd International Conference on Computer Graphics, Visualization and Computer Vision 2014**, Primavera Hotel and Congress Centrum, Plzen (close to Prague), Czech Republic. (Jan. 2014, p. 90)

2–6 **AIM Workshop: Descriptive inner model theory**, American Institute of Mathematics, Palo Alto, California. (Mar. 2014, p. 312)

2–6 **Computational Nonlinear Algebra**, Institute for Computational and Experimental Research in Mathematics, (ICERM), Brown University, Providence, Rhode Island. (Nov. 2013, p. 1398)

2–6 **Conference on Ulam's type stability**, Rytro, Poland. (Jan. 2014, p. 91)

2–6 **Discrete Groups and Geometric Structures, with Applications V**, KU Leuven, Arenberg Castle, Heverlee (nearby Leuven), Belgium. (Dec. 2013, p. 1495)

2–6 **Hamiltonian Systems and Celestial Mechanics (HAMSYS 2014)**, Centre de Recerca Matematica, Bellaterra, Barcelona, Spain. (Jan. 2014, p. 91)

2–21 **Joint ICTP - TWAS School on Coherent State Transforms, Time-Frequency and Time-Scale Analysis, Applications**, The Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy. (Mar. 2014, p. 312)

* 2–29 **ESL for the Secondary Mathematics Teacher**, Online course.
Description: Need help teaching math to English learners (ELs)? Join TESOL for this popular online course and learn about core ESL principles and practices, the role of language and culture in learning math, and how to plan and implement instruction and assessment practices for ELs. Registration closes 28 May and space is limited.
Information: http://www.tesol.org/attend-and-learn/online-courses-seminars/esl-for-the-secondary-mathematics-teacher.

* 2–30 **Algorithmic Randomness**, Institute for Mathematical Sciences, National University of Singapore, Singapore.
Description: Activities 1. Informal Collaboration: June 2–8, 2014. 2. Ninth International Conference on Computability, Complexity and Randomness (CCR 2014): June 9–13, 2014. The conference series "Computability, Complexity and Randomness" is centered on developments in Algorithmic Randomness, and the conference CCR 2014 will be part of the IMS programme. The CCR has previously been held in Cordoba 2004, in Buenos Aires 2007, in Nanjing 2008, in Luminy 2009, in Notre Dame 2010, in Cape Town 2011, in Cambridge 2012, and in Moscow 2013; it will be held in Heidelberg 2015. 3. Informal Collaboration: June 10–30, 2014.
Information: http://www2.ims.nus.edu.sg/Programs/014algo/index.php.

* 3–5 **Three days on analysis & PDEs**, Instituto de Ciencias Matemáticas C/Nicolás Cabrera, 13-15 28049 Madrid, Spain.
Description: The meeting "Three days on analysis and PDEs" aims to bring together some of the experts working in the areas of harmonic analysis (HA), partial differential equations (PDEs), and inverse problems (IPs). HA and PDEs have been closely interconnected for decades and their connection has stimulated interesting progress in both areas. Recently, IPs has taken some fundamental ideas from HA and PDEs to answer mathematical problems with promising applications. The purposes of this meeting are to reinforce the existing links between these areas and open new lines of research.
Information: http://www.icmat.es/congresos/2014/tdapde/.

* 3–6 **Fluid dynamics and electromagnetism: Theory and numerical approximation. On the occasion of Professor Paolo Secchi**

This section contains announcements of meetings and conferences of interest to some segment of the mathematical public, including ad hoc, local, or regional meetings, and meetings and symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. A complete list of meetings of the Society can be found on the last page of each issue.
An announcement will be published in the *Notices* if it contains a call for papers and specifies the place, date, subject (when applicable), and the speakers; a second announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in every third issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.
In general, announcements of meetings and conferences carry only the date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. If there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of the *Notices* in care of the American Mathematical Society in Providence or electronically to notices@ams.org or mathcal@ams.org.
In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of the *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence **eight months** prior to the scheduled date of the meeting.
The complete listing of the Mathematics Calendar will be published only in the September issue of the *Notices*. The March, June/July, and December issues will include, along with new announcements, references to any previously announced meetings and conferences occurring within the twelve-month period following the month of those issues. New information about meetings and conferences that will occur later than the twelve-month period will be announced once in full and will not be repeated until the date of the conference or meeting falls within the twelve-month period.
The Mathematics Calendar, as well as Meetings and Conferences of the AMS, is now available electronically through the AMS website on the World Wide Web. To access the AMS website, use the URL: http://www.ams.org/.

and Professor Alberto Valli 60th birthday, Bellavista Relax Hotel, Levico Terme, Trento, Italy.
Description: The Conference aims at bringing together leading scientists in the fields of Fluid Dynamics and Electromagnetism and to present high level contributions on recent developments in the theory and numerical analysis of partial differential equations related to these fields. It will be an occasion for celebrating Professor Paolo Secchi and Professor Alberto Valli 60th birthdays.
Scientific Committee: Professor Hugo Beirao da Veiga, (Pisa); Professor Diego Córdoba, (Madrid); Professor Alfio Quarteroni, (Milano, Lausanne); Professor Raul Serapioni, (Trento).
Organizing Committee: Ana Alonso Rodriguez (Trento); Luigi Carlo Berselli (Pisa); Alessandro Morando (Brescia); Paola Trebeschi (Brescia).
Information: http://events.unitn.it/en/fde2014.

3–6 **Moduli - Operads - Dynamics II**, Tallinn University of Technology, Tallinn, Estonia. (Oct. 2013, p. 1203)

4–5 **3rd International Conference on Human Computing, Education and Information Management System (ICHCEIMS 2014)**, The Grace Hotel, Sydney, Australia. (Apr. 2014, p. 429)

4–14 **School in Dynamical Systems and Ergodic Theory**, Cheikh Anta Diop University, Dakar, Senegal and African Institute for Mathematical Sciences, Mbour, Senegal. (Mar. 2014, p. 312)

5–6 **3rd International Conference on Computer Science, Information System and Communication Technology**, The Grace Hotel, Sydney, Australia. (Apr. 2014, p. 429)

5–7 (UPDATE) **Number Theory at Illinois: A Conference in Honor of the Batemans and Heini Halberstam**, University of Illinois, Urbana, Illinois. (May 2014, p. 553)

* 5–8 **Probability on Algebraic and Geometric Structures**, Southern Illinois University at Carbondale, Carbondale, Illinois.
Description: Contributed papers are sought in the areas of: Probability and random processes on groups, semigroups, and structures such as Clifford algebras and quantum groups; the analysis of random walks on Cayley graphs and other combinatorial structures; algebraic methods for the analysis of homogeneous and non-homogeneous Markov chains and products of random matrices; Stochastic partial differential equations and random process on manifolds and other geometric structures; finite and infinite dimensional stochastic dynamical systems.
Confirmed speakers: Luigi Accardi, University of Roma Tor Vergata; Denis Bell, University of North Florida; Piotr Graczyk, Université d'Angers; Göran Högnäs, Abo Akademi University; Rémi Léandre, Université de Franche-Comté; Sri Namachchivaya, University of Illinois; Francesco Russo, ENSTA-ParisTech; Patrice Sawyer, Laurentian University; René Schott, Université Henri Poincaré; Marlos Viana, University of Illinois, Chicago.
Information: http://www.math.siu.edu/pags-conference.php.

* 6–July 7 **8th Annual International Conference on Mathematics & Statistics: Education & Applications**, Athens, Greece.
Description: The conference will be held from June 30–July 1–3, 2014. The conference website is http://www.atiner.gr/edu-matsta.htm.
Information: http://www.atiner.gr/2014/CALL-EMS.htm.

6–11 **XVI-th International Conference on Geometry, Integrability and Quantization**, Sts. Constantine and Elena resort, near Varna, Bulgaria. (Apr. 2014, p. 429)

7–10 **7th Chaotic Modeling and Simulation International Conference (CHAOS2014)**, Lisbon, Portugal. (Mar. 2014, p. 312)

9–13 **AIM Workshop: The Cauchy-Riemann equations in several variables**, American Institute of Mathematics, Palo Alto, California. (Sept. 2013, p. 1110)

9–13 **Categorification and Geometric Representation Theory**, Centre de recherches mathématiques, Université de Montréal, Pavillon André-Aisenstadt, Montréal (Québec), Canada. (Dec. 2013, p. 1495)

9–13 **String Math 2014**, University of Alberta, Edmonton, Alberta, Canada. (Sept. 2013, p. 1110)

9–13 **Tenth edition of the Advanced Course in Operator Theory and Complex Analysis**, Sevilla, Spain. (Sept. 2013, p. 1110)

9–14 **Representations, Dynamics, Combinatorics: In the Limit and Beyond. A conference in honor of Anatoly Vershik's 80th birthday**, Saint-Petersburg, Russia. (Jan. 2014, p. 91)

9–15 **School on Nonlinear Analysis, Function Spaces and Applications 10**, Trest, Czech Republic. (Feb. 2014, p. 212)

9–July 4 **Interactions between Dynamics of Group Actions and Number Theory**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom. (Sept. 2013, p. 1110)

* 10–13 **Nonlinear partial differential equations and stochastic methods**, Jyväskylä, Finland (Apr. 2014, p. 430)

10–13 **Geometry of Banach Spaces - A conference in honor of Stanimir Troyanski**, Albacete, Spain. (Nov. 2013, p. 1398)

11–13 **Karatekin Mathematics Days 2014**, Karatekin University, Çankiri, Turkey. (May 2014, p. 553)

11–15 **5th Cornell Conference on Analysis, Probability, and Mathematical Physics on Fractals**, Cornell University, Ithaca, New York. (May 2014, p. 553)

12–14 **Riemann, topology and physics**, Institut de Recherche Mathematique Avancee, University of Strasbourg, Strasbourg, France. (Oct. 2013, p. 1203)

14–15 **Matm2014–Methodological Aspects of Teaching Mathematics**, Faculty of Education in Jagodina, University of Kragujevac, Serbia. (Mar. 2014, p. 313)

15–20 **4th European Seminar on Computing (ESCO 2014)**, Pilsen, Czech Republic. (Nov. 2013, p. 1398)

* 16–17 **Barcelona Computational and Systems Neuroscience (BARCSYN 2014)**, Institut d'Estudis Catalans, Barcelona, Spain.
Description: Barcsyn is about bringing together researchers from computational, systems and cognitive neuroscience. Our goal is to provide a forum for lively discussion and promote active collaboration between Barcelona-based research groups, especially between theorists and experimentalists. This is the third annual Barcsyn conference. Each day we will have 8-10 brief oral presentations from local researchers, a poster session and a longer keynote lecture from a renowned researcher from abroad.
Information: |http://www.crm.cat/en/Activities/Pages/ActivityFoldersAndPages/Curs%202013-2014/BARCSYN2014/BARCSYN2014.aspx.

16–18 **Eleventh edition of the Advanced Course in Operator Theory and Complex Analysis**, Sevilla, Spain. (Apr. 2014, p. 430)

16–19 **8th Annual International Conference on Mathematics & Computer Science**, Athens, Greece. (Oct. 2013, p. 1204)

* 16–20 **2014 Bicocca Workshop on Representation Theory**, Department of Mathematics and Applications, University of Milano-Bicocca, Milan, Italy.
Description: A summer school on McKay's Conjecture and characters of soluble groups.
Lecturers: Martin Isaacs (Madison), Gabriel Navarro (Valencia). The School will be followed by a Conference in Theoretical and Computational aspects in Representation Theory from 18th till 20th of

June. The main Speakers list includes G. Malle, Universitaet Kaiserslautern; E. Pacifici, Universita' di Milano; M. Pellegrini, Universitais de Brasilia; A. Zalesskii, University of Norwich; U. Onn, Ben Gurion University of the Negev; M. Isaacs, University of Wisconsin-Madison; G. Navarro, Universitat de Valencia; C. Fieker, Universitaet Kaiserslautern; J. Thevenaz, EPFL.
Information: http://www.matapp.unimib.it/~prevital/Bicocca2014/Bicocca2014.html.

16–20 **12th Workshop on Interactions between Dynamical Systems and Partial Differential Equations**, School of Mathematics and Statistics, Universitat Politècnica de Catalunya, Barcelona, Spain. (Apr. 2014, p. 430)

16–20 **Conference on stochastic processes and high dimensional probability distributions**, Euler International Mathematical Institute of the Russian Academy of Sciences, Saint Petersburg, Russia. (Feb. 2014, p. 212)

16–20 **NSF-CBMS Regional Research Conference "Quantum Spin Systems"**, University of Alabama at Birmingham, Birmingham, Alabama. (Apr. 2014, p. 430)

16–20 **Strathmore University International School on Spatial Modelling (ISSM-2014)**, Strathmore University, Nairobi, Kenya. (Mar. 2014, p. 313)

* 16–20 **Workshop on the Geometry and Physics of Moduli Spaces**, Miraflores de la Sierra, Madrid, Spain.
Description: The main goal of this workshop is to bring together experts in various aspects on the theory of moduli spaces and related areas, with emphasis on moduli spaces of Higgs bundles and their interplay with geometry, topology and theoretical physics. The workshop is organized within the ICMAT Research Term on the Geometry and Physics of Moduli Spaces.
Information: http://www.icmat.es/RT/GPMODULI/workshop.php.

16–27 **Fifth International Conference and School Geometry, Dynamics, Integrable Systems–GDIS 2014: Bicentennial of The Great Poncelet Theorem and Billiard Dynamics**, The Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy. (Mar. 2014, p. 313)

16–27 **Summer Graduate School: Dispersive Partial Differential Equations**, Mathematical Sciences Research Institute, Berkeley, California. (Nov. 2013, p. 1399)

* 17 **Feedback Computing '14: 9th International Workshop on Feedback Computing**, Hyatt Regency Philadelphia at Penn's Landing, Philadelphia, Pennsylvania.
Description: Join us for the 9th International Workshop on Feedback Computing. Many research disciplines such as machine learning, mathematical optimization, automatic control, cyber-physical systems, and autonomic computing rely on feedback to achieve goals such as autonomy, learning, adaptation, stabilization, robustness, or performance optimization. This workshop provides a unique forum to exchange the insights across these disciplines as the theoretical foundations of feedback, broadly defined, in computing and to share the experience pertaining to use of feedback in computing.
Information: http://www.usenix.org/conference/feedbackcomputing14.

* 17–18 **HotCloud '14: 6th USENIX Workshop on Hot Topics in Cloud Computing**, Hyatt Regency Philadelphia at Penn's Landing, Philadelphia, Pennsylvania.
Description: HotCloud brings together researchers and practitioners from academia and industry working on cloud computing technologies. Cloud computing has gained traction over the past few years, becoming a viable alternative to dedicated data centers and enabling the launch of many prominent companies. However, many challenges remain in the design, implementation, and deployment of cloud computing. HotCloud provides a forum for both academics and practitioners to share their experience, leverage each other's perspectives, and identify new/emerging "hot" trends in this important area.
Information: http://www.usenix.org/conference/hotcloud14.

* 17–18 **HotStorage '14: 6th USENIX Workshop on Hot Topics in Storage and File Systems**, Hyatt Regency Philadelphia at Penn's Landing, Philadelphia, Pennsylvania.
Description: In its 6th edition, HotStorage will continue to showcase the latest in storage systems design, implementation, management, and evaluation. We expect that workshop submissions will advocate fresh, unorthodox, unexpected, controversial, and counterintuitive approaches advancing the state of the art in many areas. Work presented at HotStorage should have the potential to lead to publications in future top-tier systems conferences. The HotStorage workshop aims to provide a forum for the cutting edge in storage research where researchers can exchange ideas and engage in discussions with their colleagues.
Information: http://www.usenix.org/conference/hotstorage14.

* 17–20 **FCW '14: 2014 USENIX Federated Conferences Week**, Hyatt Regency Philadelphia at Penn's Landing, Philadelphia, Pennsylvania.
Description: Back for 2014, USENIX is combining conferences and workshops, both established and new, into one week chock full of research, training, and information. The USENIX Federated Conferences Week offers a unique opportunity to gain insight into a variety of hot topics, while the joint lunches, breaks, and evening events provide cross-topic networking possibilities.
Information: http://www.usenix.org/conference/fcw14.

17–20 **First International Congress on Actuarial Science and Quantitative Finance**, Universidad Nacional de Colombia, Bogota, Colombia. (Jan. 2014, p. 91)

* 18–20 **Boise Extravaganza in Set Theory 2014**, University of California, Riverside, California.
Description: We are pleased to announce that BEST 2014 will be held on the campus of UC Riverside during June 18-20, 2014, as a symposium of the 95th Annual Meeting of the Pacific Division of the American Association for the Advancement of Science. The mission of BEST is to provide a forum for interactions between set theory and related areas of mathematics and between mathematics and natural sciences, a conference that will integrate student and postdoc dissemination of research, and provide an opportunity for interaction between the leaders in the field and set theorists early in their careers. Mathematicians in set theory and related areas, including graduate and undergraduate students, are welcome to present their research results at the meeting. Participation by women and underrepresented groups is strongly encouraged. NSF funding to support travel grants for conference speakers is pending. Please visit the conference website for further details.
Information: http://diamond.boisestate.edu/~best/.

18–20 **XIV Encuentro de Algebra Computacional y Aplicaciones EACA 2014**, Barcelona, Spain. (Mar. 2014, p. 313)

18–27 **Summer school on the Gan-Gross-Prasad conjectures**, Institut de Mathématiques de Jussieu - Paris, Rive Gauche 4, place Jussieu, Paris, France. (Feb. 2014, p. 212)

* 19 **UCMS '14: 2014 USENIX Configuration Management Summit**, Hyatt Regency Philadelphia at Penn's Landing, Philadelphia, Pennsylvania.
Description: At the 2014 USENIX Configuration Management Summit (UCMS '14), we will continue to bring the configuration management community together to advance the state of configuration management, discuss its problems and solutions, and enhance the community of this growing field.

Information: http://www.usenix.org/conference/ucms14.

* 19–20 **USENIX ATC '14: 2014 USENIX Annual Technical Conference**, Hyatt Regency Philadelphia at Penn's Landing, Philadelphia, Pennsylvania.
Description: USENIX ATC '14 will bring together leading systems researchers for cutting-edge systems research and unlimited opportunities to gain insight into a variety of must-know topics, including virtualization, system administration, cloud computing, security, and networking.
Information: http://www.usenix.org/conference/atc14.

* 20 **URES '14: 2014 USENIX Release Engineering Summit**, Hyatt Regency Philadelphia at Penn's Landing, Philadelphia, Pennsylvania.
Description: In the first USENIX Release Engineering Summit (URES .14), we will bring members of the release engineering community together to advance the state of release engineering, discuss its problems and solutions, and enhance the community of this quickly growing field. We solicit original presentations and discussions on a wide range of topics, but we particularly encourage presentations on novel, pragmatic approaches and solutions to vexing problems in release engineering.
Information: http://www.usenix.org/conference/ures14.

21–August 3 **MSRI-UP 2014: Arithmetic Aspects of Elementary Functions**, Mathematical Sciences Research Institute, Berkeley, California. (Nov. 2013, p. 1399)

22–28 **The Fourth International School-Seminar "Nonlinear Analysis and Extremal Problems"**, Institute of System Dynamics and Control Theory SB RAS, Irkutsk, Russia. (Apr. 2014, p. 430)

22–29 **The 52nd International Symposium on Functional Equations**, Innsbruck, Austria. (Feb. 2014, p. 212)

22–July 6 **9th International Summer School and Conference "Let's Face Chaos through Nonlinear Dynamics"**, CAMTP, University of Maribor, Maribor, Slovenia, European Union. (Apr. 2014, p. 430)

23 **One-Day Conference on Geometry and Statistics**, Department of Mathematical Sciences, University of Bath, Bath, United Kingdom. (May 2014, p. 553)

23–25 **17th Conference on Integer Programming and Combinatorial Optimization (IPCO 2014)**, University of Bonn, Bonn, Germany. (Sept. 2013, p. 1110)

23–26 **International Congress in Honour of Professor Ravi P. Agarwal**, The Auditorium at the Campus of Uludag University, Bursa, Turkey. (Apr. 2014, p. 430)

* 23–26 **V Jaen Conference on Approximation, Computer Aided Geometric Design, Numerical Methods and Applications**, Universidad de Jaen, Ubeda, Jaen, Spain.
Description: The Conference is an activity of the Jaen Approximation Project. It has organized ten editions of the Ubeda Meeting on Approximation and four editions of the Jaen Conference on Approximation. It also issues the *Jaen Journal on Approximation* from 2009. The Conference will be devoted to some significant aspects on Approximation Theory, Computer Aided Geometric Design, Numerical Methods and the applications of these fields in other areas.
Plenary Speakers: Alicia Cachafeiro, Erik Koelink, Paul Nevai, Edward B. Saff, Kurt Jetter, Guillermo Lopez-Lagomasino, Paul Sablonniere, Jungho Yoon. The conference will take place in Úbeda (Spain), a World Heritage Site. This edition will be dedicated to the 5th anniversary of the *Jaen Journal on Approximation*. Editors, authors, referees or subscribers of the *Jaen Journal on Approximation* and members of editorial boards of scientific journals will obtain special fees.
Information: http://www.ujaen.es/revista/jja/jca/.

23–27 **12th Biennial IQSA Meeting Quantum Structures Olomouc 2014**, Palack University Olomouc, Faculty of Science, Olomouc, Czech Republic. (Apr. 2014, p. 430)

23–27 **Boltzmann, Vlasov and related equations: Last results and open problems**, University of Cartagena, Cartagena, Colombia. (Nov. 2013, p. 1399)

23–27 **Conference on Differential and Difference Equations and Applications 2014 (CDDEA 2014)**, Jasná, Slovak Republic. (Apr. 2014, p. 430)

* 23–27 **INdAM Workshop on Singular and Degenerate Evolution Problems**, Palazzone della Scuola Normale, Cortona, Italy.
Description: The aim is to bring together the leading experts in the field of degenerate and singular evolution problems, postdoctoral researches and graduate students, in order to discuss and share ideas on the major open problems, to suggest novel research perspectives, and to develop new scientific connections.
Information: http://www.imati.cnr.it/~gianazza/cortona14.html.

23–27 **International conference "Dynamical Systems and Their Applications"**, Institute of Mathematics of National Academy of Sciences of Ukraine, Kyiv, Ukraine. (Apr. 2014, p. 431)

23–27 **Microlocal analysis and applications**, Université de Nice Sophia Antipolis, Nice, France. (Dec. 2013, p. 1495)

23–27 **Mini-courses in Mathematical Analysis 2014**, University of Padova, Padova, Italy. (May 2014, p. 554)

* 23–27 **Noncommutative Analysis, Operator Theory and Applications**, Department of Mathematics, Politecnico Milano, Milano, Italy.
Description: This international conference is organized with pedagogical and research aims. It will be devoted to several aspects of the current research activity in operator theory, operator algebras and applications in various areas of mathematics and mathematical physics. Its purpose is to bring together specialists from several fields including global analysis, Schur analysis, (hyper)complex analysis, $C*$-algebras, noncommutative geometry, operator algebras, operator theory and their applications.
Topics: The topics covered, though in different areas, are all intertwined between them and have several applications which will be addressed in the Conference. A special attention will be paid to young speakers and participants: one of the main goals will be to create an appropriate environment in which Ph.D. students, PostDoc students and junior researchers may find the opportunity to meet and discuss with first rate senior researchers.
Information: http://www.eko.polimi.it/index.php/nao2014/NAOA2014

23–27 **What Next? The mathematical legacy of Bill Thurston**, Cornell University, Ithaca, New York. (Sept. 2013, p. 1110)

23–28 **6th International Conference on Advanced Computational Methods in Engineering**, NH Gent Belfort, Gent, Belgium. (Sept. 2013, p. 1110)

* 23–April 10, 2015 **Thematic Year 2014-2015: Number Theory from Arithmetic Statistics to Zeta Elements**, Centre de recherches mathématiques, Université de Montréal, Montréal, Canada.
Description: Number theory enjoys a privileged position within mathematics as a fertile source of fundamental questions. Among the seven Millenium Problems listed by the Clay Institute, not less than three—the Birch and Swinnerton-Dyer conjecture, the Hodge conjecture, and the Riemann hypothesis—were handed down by the Queen of Mathematics.
Information: http://www.crm.umontreal.ca/Number2014/.

* 24–27 **Iberoamerican Conference on Topology and its Applications. CITA-2014**, University of Almeria, Almeria, Spain.
Description: The 9th edition, that will take place in Almeria from 24 to 27 of June 2014, is the continuation of the Iberoamerican Conference editions, which have been developed in the following cities: Benicàssim (Spain, 1995), Morelia (México, 1997), Gandia (Spain, 1999), Coimbra (Portugal, 2001), Lorca (Spain, 2003), Puebla

(México, 2005), Valencia (Spain, 2008), Guanajuato (Mexico, 2012). This conference is dedicated to Topology and its Applications. There are special sessions on: asymmetric topology, fuzzy metrics and related structures; general topology and set-theoretic topology; topological algebra and dynamical systems; topology for functional analysis; topological geometry and continuum theory. All researchers are invited to participate, especially from Iberoamerican countries.
Information: http://congresos.ual.es/cita-2014/ficha.en.html.

24–27 **Mathematics Meets Physics**, University of Helsinki, Finland. (Feb. 2014, p. 213)

24–28 **Flint: One City — 100 Years Under Variability**, Kettering University, 1700 University Ave., Flint, Michigan. (May 2014, p. 554)

26–July 1 **Sixth International Conference for Promoting the Application of Mathematics in Technical and Natural Sciences (AMiTaNS'14)**, Black-Sea resort, Albena, Bulgaria. (Feb. 2014, p. 213)

28–July 2 **Conference Board of Mathematical Sciences/National Science Foundation: Mathematical Phylogeny Conference**, Winthrop University, Rock Hill, South Carolina. (Apr. 2014, p. 431)

29–July 3 **26th International Conference on Formal Power Series and Algebraic Combinatorics (FPSAC)**, DePaul University, Chicago, Illinois. (Sept. 2013, p. 1110)

* 29–July 5 **XXXIII Workshop on Geometric Methods in Physics**, Bialowieza, Poland.
Description: The venue is in the heart of the Bialowieza; a primeval forest. Transportation from Warsaw and back is provided. The program consists of invited plenary lectures (55 minutes), as well as other invited and contributed talks and posters. We encourage participation of younger scientists.
Topics: Integrable systems, mathematical aspects of field theory, operator algebras and noncommutative geometry, infinite-dimensional groups, Poisson geometry, quantization, Lie groupoids and Lie algebroids.
Confirmed plenary speakers: Rui Loja Fernandes (Urbana, IL), Alexander Gayfullin (Moscow), Vassily Gorbounov (Aberdeen) , Andrey Lazarev (Lancaster), Martin Markl (Praha), Alexander Mikhailov (Leeds), Nikolay Moshchevitin (Moscow), Ali Mostafazadeh (Istanbul), Karl-Hermann Neeb (Erlangen), Stefan Nemirovski (Moscow), Sylvie Paycha (Potsdam), Fernand Pelletier (Savoie), Anton Savin (Moscow), Andrzej Sitarz (Kraków), Walter van Suijlekom (Nijmegen), and Alexander Voronov (Minneapolis).
Organizer: This annual international conference is organized by the Department of Mathematical Physics of the University of Bialystok, Poland, and is held at the resort town of Bialowieza.
Information: http://wgmp.uwb.edu.pl/.

* 29–July 6 **Introduction to the geometry of jet spaces and nonlinear differential equations. Summer School**, Wisla, Beskid Mountains, Poland.
Description: Baltycki Instytut Matematyki would like to announce "Introduction to the geometry of jet spaces and nonlinear differential equations. Summer School."
Lectures: By Joseph Krasil'shchik, Alexander Verbovetsky, Introduction: Smooth manifolds, vector bundles, distributions; jets of bundles, nonlinear differential operators; the Cartan distribution; geometry of the Cartan distribution, Lie transformations. contact transformations; Lie-Bäcklund Theorem; nonlinear differential equations, prolongations, infinite jets; evolutionary derivations and higher symmetries; examples of computation; Applications: Integrability of ODEs in quadratures and Lie-Bianchi Theorem; Applications: invariant solutions and solitons.
Information: http://baltinmat.eu/summer-school-2014/.

30–July 3 **8th Annual International Conference on Statistics**, The Mathematics & Statistics Research Unit (ATINER), Athens Institute for Education and Research, Athens, Greece. (Feb. 2014, p. 213)

* 30–July 4 **8th International Summer School on Geometry, Mechanics and Control**, Residencia La Cristalera, 28792 Miraflores de la Sierra, Madrid, Spain.
Description: The school is oriented to young researchers, Ph.D. and postdoctoral students in Mathematics, Physics and Engineering, in particular those interested in focusing their research on geometric control and its applications to mechanical and electrical systems, and optimal control. It is intended to present an up-to-date view of some fundamental issues in these topics and bring to the participants attention some open problems, in particular problems related to applications. This year the courses will be delivered by: Yuri B. Suris, Technische Universität Berlin, Germany; Juan Pablo Ortega, CNRS, Université de Franche-Comté, France; François Gay Balmaz, CNRS, Ecole Normale Supérieure-Paris, France. This School is an activity within the ICMAT Severo Ochoa Excellence Program.
Information: http://gmcnetwork.org/drupal/?q=activity-detaill/1116.

* 30–July 5 **Advance in Mathematical Fluid Mechanics, Stochastic and Deterministic Methods**, University of Lisbon, Lisbon, Portugal.
Description: The aim of this scientific meeting is to present and discuss recent progresses in the Stochastic & Deterministic theory of Navier-Stokes equations, Euler equations and related problems.
Topics: Thermodynamics and Statistical Mechanics; Variational methods in Fluids (deterministic and stochastic). Optimal Transport in fluid mechanics; Well-posedness of solutions. Boundary conditions: no-slip, slip, artificial. Zero viscosity limit and large deviation techniques. This scientific meeting will be a Satellite Conference of the 10th AIMS Conference on Dynamical Systems Differential Equations and Applications, July 07-July 11, 2014, Madrid, Spain.
Information: http://gfm.cii.fc.ul.pt/amfm2014/index.html.

30–July 5 **25th International Conference in Operator Theory**, West University of Timisoara, Timisoara, Romania. (Jan. 2014, p. 91)

30–July 6 **16th Baikal International Triannual School-Seminar "Methods of Optimization and Their Applications"**, Baikalov Ostrog, Olkhon island, Lake Baikal, Russia. (Mar. 2014, p. 313)

30–July 11 **Advanced School on PDEs in Geometry and Physics**, University of Science and Technology of China, Hefei, People's Republic of China. (May 2014, p. 554)

30–July 25 **Clay Mathematics Institute Summer School 2014 Periods and Motives: Feynman amplitudes in the 21st century**, ICMAT, Instituto de Ciencias matemáticas, Madrid, Spain. (Mar. 2014, p. 314)

July 2014

* 1–5 **Harmonic Analysis to celebrate Michael Cowling's 65th**, Segovia, Spain.
Description: This is a five day workshop in Harmonic Analysis funded principally by the European Research Council. Participants may also be interested in attending the 10th AIMS Conference on Dynamical Systems, Differential Equations and Applications in Madrid the week after.
Location: The talks will take place in the Hotel San Antonio El Real, a refurbished 15th century monastery located 10 mins walk from the Roman aqueduct in Segovia San Antonio El Real, s/n 40004.
Information: http://www.icmat.es/rogers/ERCworkshop/.

* 1–5 **International Conference on New Trends in the Applications of Differential Equations in Sciences (NTADES 2014)**, Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, Sofia, Bulgaria.
Description: International conference on New Trends of Differential Equations in Sciences is organized by the Department of Differential Equations and Mathematical Physics at the Institute of Mathematics and Informatics, Bulgarian Academy of Sciences. Differential equations have a lot of applications in different scientific fields.

This conference will be devoted to such applications. A number of phenomena in nature (physics, chemistry, biology) and in society (economics) result in problems leading to study of linear and nonlinear differential equations. The conference consists of invited and contributed papers. Prospective authors are invited to submit their papers on topics including but not limited to applications of differential equations in: Mathematical Physics; Mathematical Finance; Mathematical Biology; Nonlinear Waves; Mechanics; Neuroscience. The proceedings will be published in *Pliska Studia Mathematica Bulgarica* (http://www.math.bas.bg/~pliska/).
Information: http://www.math.bas.bg/ntades.

1–6 **Random Matrix Theory: Foundations and Applications**, Jagiellonian University, Krakw, Poland. (Mar. 2014, p. 314)

2–4 **The 2014 International Conference of Applied and Engineering Mathematics**, Imperial College London, London, United Kingdom. (Jan. 2014, p. 91)

* 3–4 **International Workshop on Boundary Value Problems: New Trends and Applications–2014 (IWBVP2014)**, Évora, Portugal.
Description: This event is sponsored by Research and Advanced Training Institute (IIFA) - University of Évora and Research Centre for Mathematics and Applications (CIMA). This workshop aims to promote, encourage and influence more cooperation, understanding, and collaboration among scientists working in Boundary Value Problems both in Differential and Difference Equations. Special emphasis will be given to real phenomena arising in mathematical models and applications. The conference will host both invited presentations and contributed talks. Selected and peer reviewed articles will be published in the conference proceedings.
Information: http://www.iwbvp2014.uevora.pt/index.php?/event.

* 3–4 **Journées de théorie de l'Homotopie en l'honneur de Jean Lannes et Bob Oliver**, University Paris 7 and University Paris 13, Paris, France.
Description: L'équipe de topologie algébrique du LAGA organise les 3 et 4 Juillet 2014 deux journées de théorie de l'homotopie en l'honneur de Jean Lannes et Bob Oliver à l'occasion de leur départ en retraite.
Conférenciers: D. Benson (Aberdeen), Matrix factorisations and elementary abelian p-groups; G. Chenevier (Polytechnique); W. Dwyer (Notre Dame); M. Livernet (Paris 13), Recognition of relative loop spaces; H. Miller (MIT); J. Moller (Copenhague), Homotopy equivalences between categories of p-subgroups; F. Morel (Munich), The tree of SL_2 over polynomial rings and the Friedlander-Milnor conjecture for SL_2; R. Stancu (Amiens), Saturation et éléments caractéristiques des systèmes de fusion/Saturation and characteristic elements of fusion systems; C. Vespa (Strasbourg), Homologie stable des groupes à coefficients tordus.
Information: http://www.math.univ-paris13.fr/jlo/.

3–7 **CMMSE 2014: 14th International Conference Computational and Mathematical Methods in Science and Engineering**, Costa Ballena, Cadiz, Spain. (May 2014, p. 554)

3–7 **2014 International Conference on Topology and its Applications**, University of Patras and Technological Educational Institute of Western Greece, Nafpaktos, Greece. (Feb. 2014, p. 213)

6–10 **CBMS conference on Higher Representation Theory**, North Carolina State University, Raleigh, North Carolina. (Apr. 2014, p. 431)

7–10 **International Conference "Mathematics Days in Sofia"**, Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, Sofia, Bulgaria. (Feb. 2014, p. 213)

7–11 **10th AIMS Conference on Dynamical Systems, Differential Equations and Applications**, Universidad Autónoma de Madrid, Madrid, Spain. (Sept. 2013, p. 1111)

7–11 **2nd Barcelona Summer School on Stochastic Analysis**, Centre de Recerca Matematica, Bellaterra, Barcelona, Spain. (Mar. 2014, p. 314)

7–11 **Conferences on Intelligent Computer Mathematics, CICM 2014**, University of Coimbra, Coimbra, Portugal. (Dec. 2013, p. 1496)

* 7–11 **International Conference in Geometric Analysis**, Lisbon, Portugal.
Description: Geometric Analysis is a very active field of research, with several well known open problems being solved at a very fast pace. We aim to present some of these developments.
Confirmed speakers: B. Andrews, J. Cheeger, F. Coda Marques, T. Colding, T. Ilmanen, N. Hitchin, B. Kleiner, C. LeBrun, B. Minicozzi, A. Naber, A. Nabutovsky, N. Nadirashvili, T. Riviere, A. Ros, M. Rupflin, R. Schoen, G. Tian, B. White, N. Wickramasekera, B. Wilking and X. Zhou.
Information: http://gac.math.tecnico.ulisboa.pt/.

* 7–12 **III School on Geometry and Physics**, Bialowieza, Poland.
Description: This school for young researchers is organized in conjunction with the annual Workshop on Geometric Methods in Physics in Bialowieza. It will take place in the week following the conference. The total cost of the school is 300 EUR (includes transportation, board, and accommodation). During the school we plan to organize several 3h courses presented by leading experts in mathematical physics and geometry such as Alexander Belavin (Moscow), Pierre Bieliavsky (Louvain), Kirill Mackenzie (Sheffield), Yuri Neretin (Moscow/Vienna), Theodore Voronov (Manchester), and Wojciech Wojtynski (Bialystok). The list of the lecturers is not final yet and additional lecturers may be included.
Organizer: Department of Mathematical Physics of the University of Bialystok, Poland.
Information: http://wgmp.uwb.edu.pl/second.html.

* 7–18 **The 9th annual AMSI Winter School on Contemporary Aspects of Cryptography**, The University of Queensland, Brisbane, Australia.
Description: Cryptography is the practice and study of techniques for secure communication in the presence of third parties, i.e., making codes and breaking codes.
Speakers: Professor Tanja Lange (Eindhoven Institute for the Protection of Systems and Information, The Netherlands); Professor Alexei Miasnikov (Stevens Institute of Technology, USA); Dr. Douglas Stebila (Queensland University of Technology, Australia); Professor Andrew White (University of Queensland, Australia); Assoc. Professor Serdar Boztas (RMIT, Australia). The school comprises broad introductory lectures in the first week, with specialist lectures in the second week and is open to undergraduate, honours and post-graduate students, researchers and employees working in the area. `
Information: http://www.amsi.org.au/WS.

7–18 **Summer Graduate School: Stochastic Partial Differential Equations**, Mathematical Sciences Research Institute, Berkeley, California. (Nov. 2013, p. 1399)

7–August 29 **The Geometry, Topology and Physics of Moduli Spaces of Higgs Bundles**, Institute for Mathematical Sciences, National University of Singapore, Singapore. (Nov. 2013, p. 1399)

8–11 **2014 World Conference on Natural Resource Modeling**, Vilnius University, Vilnius, Lithuania. (Dec. 2013, p. 1496)

9–11 **10th International Workshop on Automated Deduction in Geometry, ADG 2014**, University of Coimbra, Coimbra, Portugal. (Dec. 2013, p. 1496)

9–12 **Applications of Computer Algebra, ACA 2014**, Fordham University, New York, New York. (Dec. 2013, p. 1496)

13–15 **8th International Conference on Modelling in Industrial Maintenance and Reliability (MIMAR)**, St. Catherine's, Oxford, United Kingdom. (Oct. 2013, p. 1204)

14–17 **International Workshop on Neurodynamics (NDy14)**, CIEM, Castro-Urdiales, Spain. (May 2014, p. 554)

14–18 **AIM Workshop: Mori program for Brauer log pairs in dimension three**, American Institute of Mathematics, Palo Alto, California. (Sept. 2013, p. 1111)

14–18 **First announcement of the 25th International Workshop of Operator Theory and its Applications (IWOTA 2014)**, Amsterdam, The Netherlands. (Apr. 2014, p. 431)

14–18 **The 30th International Colloquium on Group Theoretical Methods in Physics**, Ghent University, Ghent, Belgium. (Sept. 2013, p. 1111)

14–August 8 **Theory of Water Waves**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom. (Sept. 2013, p. 1111)

* 18–August 2 **XVII Summer Diffiety School on the Geometry of PDEs**, Centro Culturale "Martignano", Lizzano in Belvedere (BO), Italy.
Description: The aim of this permanent school is to introduce undergraduate and Ph.D. students in mathematics and physics as well as post-doctoral researchers in specific area of mathematics and theoretical physics: Secondary Calculus. A diffiety is a geometrical object that properly formalizes the concept of the solution space of a given system of (nonlinear) PDEs, much as an algebraic variety does with respect to solutions of a given system of algebraic equations. Secondary calculus is a natural diffiety analogue of the standard calculus on smooth manifolds, and as such leads to a very rich general theory of nonlinear PDEs. Moreover, there are indications that it could be a natural language for quantum physics, just as the standard calculus is for classical physics.
Information: `http://sites.google.com/site/levicivitainstitute/xvii-summer-diffiety-school`.

20–25 **Sixteenth International Conference on Fibonacci Numbers and Their Applications**, Rochester Institute of Technology, Rochester, New York. (Oct. 2013, p. 1204)

21–24 **Mixed Integer Programming (MIP) workshop 2014**, The Ohio State University, Columbus, Ohio. (Feb. 2014, p. 213)

21–25 **Geometric and Asymptotic Group Theory with Applications (GAGTA)**, The University of Newcastle, Australia.

* 21–25 **ICERM Topical Workshop: Challenges in 21st Century Experimental Mathematical Computation**, Brown University, Providence, Rhode Island.
Description: Over the past 25 years, experimental mathematics has developed as an important additional arrow in the mathematical quiver. Many mathematical scientists now use powerful symbolic, numeric and graphic (sometimes abbreviated "SNAG") computing environments in their research, in a remarkable departure from tradition. While these tools collectively are quite effective, challenges remain in numerous areas, including: (a) rapid, high-precision computation of special functions and their derivatives; (b) user-customizable symbolic computing; (c) graphical computing; (d) data-intensive computing; and (e) large-scale computing on parallel and GPU architectures (including algorithm and software design for such systems). This workshop will convene mathematical and computer scientists who create or exploit these tools, together with computational tool developers and commercial vendors of mathematical software, to exchange approaches and extend the state of the art in the field.
Information: `http://icerm.brown.edu/tw14-5-cemc/`.

21–25 **Mathematics and Engineering in Marine and Earth Problems**, University of Aveiro, Portugal. (Feb. 2014, p. 213)

21–25 **Perspectives of Modern Complex Analysis**, Banach Conference Center, Bedlewo, Poland. (Feb. 2014, p. 213)

* 21–30 **PIMS Summer School and Workshop on the Economics and Math of Systemic Risk and Financial Networks**, University of British Columbia, Vancouver, British Columbia, Canada.
Description: As the financial crisis of 2008 and the Flash Crash of 2010 show, the financial networks underlying the world's economy have failed in the past, and may do so again, with catastrophic consequences. Understanding how financial markets generate and propagate risk, and how regulations can help mitigate that risk, is vital to lowering the chance of future financial meltdowns. This July, top financial mathematicians will gather at the University of British Columbia to focus on these crucial issues. The Pacific Institute for the Mathematical Sciences (PIMS) will host a summer school on systemic risk from July 21–25 followed by a workshop, featuring more than 15 presentations by top mathematicians and industry representatives, from July 28–30.
Information: For more information or to register: `http://www.pims.math.ca/scientific/focus-periods/systemic-risk-and-financial-networks`.

21–August 15 **Quantum Control Engineering: Mathematical Principles and Applications**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom. (Sept. 2013, p. 1111)

22–25 **Workshop on Infinite Dimensional Analysis Buenos Aires 2014**, Buenos Aires, Argentina. (Mar. 2014, p. 314)

23–25 **International Symposium on Symbolic and Algebraic Computation (ISSAC 2014)**, Kobe University, Japan. (Dec. 2013, p. 1496)

23–26 **29th Summer Conference on Topology and its Applications**, College of Staten Island, City Univ. of New York, New York, New York. (Apr. 2014, p. 431)

28–August 1 **99 years of General Relativity: ESI-EMS-IAMP Summer School on Mathematical Relativity**, Erwin Schrödinger Institute, Vienna, Austria. (Mar. 2014, p. 314)

* 28–August 1 **Workshop String Geometry and Loop Spaces**, University of Greifswald, Greifswald, Germany.
Description: String geometry is a rather new area of mathematics that combines topology, differential geometry and higher topos theory. String geometry is supposed to provide important foundations for fermionic string theories; in terms of this motivation, string geometry corresponds to a version of spin geometry on loop spaces. This correspondence imposes interesting questions for the geometry and topology of loop spaces, for instance concerning an appropriate index theory on loop spaces. If you would like to participate, please register on our webpage before June 15, 2014.
Information: `http://www.math-inf.uni-greifswald.de/~waldorf/loopspaces/`.

28–August 1 **XXIII Escola de Álgebra (Brazilian Algebra Meeting)**, Universidade Estadual de Maringá, Maringá, Paraná/Brazil. (Apr. 2014, p. 431)

28–August 1 **The 2014 Brock International Conference on Groups, Rings and Group Rings**, Brock University, St. Catharines, Ontario, Canada. (May 2014, p. 554)

28–August 8 **Poisson 2014 - International Conference and School on Poisson Geometry in Mathematics and Physics**, University of Illinois at Urbana-Champaign, Champaign, Illinois. (Apr. 2014, p. 431)

28–August 8 **Summer Graduate School: Geometry and Analysis**, Mathematical Sciences Research Institute, Berkeley, California. (Nov. 2013, p. 1399)

August 2014

* 3–8 **Geometric Control Theory and Analysis on Metric Structures**, The Kumutkan Recreation Centre, Lake Baikal, Russia.
Description: The conference is organized by the Geometric Control Theory Laboratory of the Sobolev Institute of Mathematics (SB RAS) in the frame of the grant "Geometric Control Theory and Analysis on

Metric Structures". It is a satellite meeting to ICM 2014. Geometric control theory naturally describes mathematical models of various applied problems, mainly in physics, technology and economics. Arising complicated problems lead to necessity of creation of new fundamental concepts of (sub)riemannian geometry and geometric analysis, and inventing new methods to solve them.
Aim: The aim of the event is to bring researchers, working in the mentioned and related domains, to report recent progress and discuss further challenging problems in the fields with the purpose to formulate them for young participants also. As a satellite meeting to ICM2014 we want to provide an opportunity for both experts and young researchers from different countries to discuss their results and to start new collaborations.
Information: http://agora.guru.ru/GCT-Baikal-2014/eng.

3–9 **XIX EBT - 19th Brazilian Topology Meeting**, State University of São Paulo (UNESP), São José do Rio Preto, Brazil. (Jan. 2014, p. 81)

4–8 **Kazhdan-Lusztig theory and Soergel bimodules**, University of Oregon, Eugene, Oregon. (Apr. 2014, p. 431)

4–9 **10th International Conference on Clifford Algebras and their Applications in Mathematical Physics (ICCA10)**, University of Tartu, Tartu, Estonia. (Sept. 2013, p. 1111)

* 5–10 **The Thin Manifold: A conference and graduate student workshop on knots and 3-manifolds**, University of Iowa, Iowa City, Iowa.
Description: The conference will be preceded by a workshop for graduate students on August 5–7 led by Jessica Purcell.
Confirmed speakers: Ken Baker, Ryan Blair, Sean Bowman, Marion Campisi, Alex Coward, Mario Eudave-Muoz, Dave Futer, Cameron Gordon, Jesse Johnson, Fabiola Manjarrez-Gutiérrez, Jessica Purcell, Trent Schirmer, Abby Thompson, and Alex Zupan.
Organizers: Scott Taylor and Maggy Tomova.
Information: http://www.colby.edu/thinmanifold.

6–10 **International Conference on K-Theory and Related Topics**, Chinese Academy of Sciences, Beijing, China. (Apr. 2014, p. 431)

7–10 **International Workshop on Applied Topology**, Chonbuk National University, Jeonju city, South Korea. (Mar. 2014, p. 315)

11–14 **SIAM Conference on Nonlinear Waves and Coherent Structures (NW14)**, Churchill College, University of Cambridge, Cambridge, United Kingdom. (Sept. 2013, p. 1111)

11–15 **AIM Workshop: Neglected infectious diseases**, American Institute of Mathematics, Palo Alto, California. (Oct. 2013, p. 1204)

11–15 **ALTENCOA6-2014**, Departamento de matemáticas y Estadistica, Universidad de Nariño, San Juan de Pasto, Colombia. (May 2014, p. 554)

11–December 12 **New geometric methods in number theory and automorphic forms**, Mathematical Sciences Research Institute, Berkeley, California. (Sept. 2013, p. 1111)

11–December 19 **Understanding Microbial Communities; Function, Structure and Dynamics**, Isaac Newton Institute, Cambridge, United Kingdom. (Oct. 2013, p. 1204)

12–14 **Third Seminar on Algebra and its Applications**, University of Mohaghegh Ardabili, Ardabil, Iran. (May 2014, p. 554)

12–16 **13th International Conference on p-adic Functional Analysis**, University of Paderborn, Paderborn, Germany. (May 2014, p. 555)

14–15 **Connections for Women: New Geometric Methods in Number Theory and Automorphic Forms**, Mathematical Sciences Research Institute, Berkeley, California. (Sept. 2013, p. 1111)

17–22 **Recent Developments in Adaptive Methods for PDEs, Collaborative Workshop and Short Course**, Memorial University of Newfoundland, St. John's, Newfoundland, Canada. (Jan. 2014, p. 92)

* 18 **CSET '14: 7th Workshop on Cyber Security Experimentation and Test**, Manchester Grand Hyatt, San Diego, California.
Description: CSET invites submissions on the science of cyber security evaluation, as well as experimentation, measurement, metrics, data, and simulations as those subjects relate to computer and network security and privacy. The "science" of cyber security poses significant challenges: very little data are available for research use, and little is understood about what good data would look like if it were obtained. Meeting these challenges requires transformational advances, including understanding the relationship between scientific method and cyber security evaluation, advancing capabilities of underlying experimental infrastructure, and improving data usability.
Information: http://www.usenix.org/conference/cset14.

* 18 **3GSE '14: 2014 USENIX Summit on Gaming, Games, and Gamification in Security Education**, Manchester Grand Hyatt, San Diego, California.
Description: The USENIX Summit on Gaming, Games and Gamification in Security Education (3GSE '14), to be co-located with USENIX Security '14, is designed to bring together educators and game designers working in the growing field of digital games, non-digital games, pervasive games, gamification, contests, and competitions for computer security education. The summit will attempt to represent, through invited talks, panels, and demonstrations, a variety of approaches and issues related to using games for security education.
Information: http://www.usenix.org/conference/3gse14.

* 18 **FOCI '14: 4th USENIX Workshop on Free and Open Communications on the Internet**, Manchester Grand Hyatt, San Diego, California.
Description: To bring together researchers and practitioners working on means to study, detect, or circumvent practices that inhibit free and open communications on the Internet.
Information: http://www.usenix.org/conference/foci14.

* 18–19 **EVT/WOTE '14: 2014 Electronic Voting Technology Workshop/Workshop on Trustworthy Elections**, Manchester Grand Hyatt, San Diego, California.
Description: EVT/WOTE brings together researchers from a variety of disciplines, ranging from computer science and human-computer interaction experts through political scientists, legal experts, election administrators, and voting equipment vendors.
Information: http://www.usenix.org/conference/evtwote14.

* 18–21 **LMS Workshop on Operator Methods in Harmonic Analysis**, Queen's University Belfast, Belfast, United Kingdom.
Description: This four-day workshop, funded by the London Mathematical Society and Queen's University Belfast, will focus on the interactions between Abstract Harmonic Analysis and Operator Algebras. Its aim is to enhance the interchange of ideas in the area and inform the participants about latest developments in this exciting part of modern mathematics. The programme of the workshop will comprise ten invited lectures as well as contributed talks. Afternoon research sessions will be scheduled with the aim of research collaboration and informal interactions.
Information: http://sites.google.com/site/omha2014/.

* 18–22 **Introductory Workshop: New Geometric Methods in Number Theory and Automorphic Forms**, Mathematical Sciences Research Institution, Berkeley, California.
Description: The goal of this workshop is to give a practical introduction to some of the main topics and techniques related to the August-December 2014 MSRI program, "New geometric methods in number theory and automorphic forms." The workshop is aimed at graduate students and interested researchers in number theory or related fields. There will be lecture series on periods of automorphic forms, Shimura varieties, and representations of p-adic groups, as well as more advanced topics, including p-adic Hodge theory and the cohomology of arithmetic groups.

Information: http://www.msri.org/workshops/710.

18–December 19 **Geometric Representation Theory**, Mathematical Sciences Research Institute, Berkeley, California. (Sept. 2013, p. 1111)

18–December 19 **Systemic Risk: Mathematical Modelling and Interdisciplinary Approaches**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom. (Mar. 2014, p. 315)

* 19 **HealthTech '14: 2014 USENIX Summit on Health Information Technologies**, Manchester Grand Hyatt, San Diego, California.
Description: HealthTech, formerly HealthSec, is now in its second year with a broader scope designed to encourage the development of new technologies that generally improve the quality and safety of healthcare as well as the access to it. By bringing together researchers, practitioners, and industrial partners, HealthTech aims to provide a forum for cross-disciplinary interactions among the technology, medicine, and policy communities.
Information: http://www.usenix.org/conference/healthtech14.

* 19 **HotSec '14: 2014 USENIX Summit on Hot Topics in Security**, Manchester Grand Hyatt, San Diego, California.
Description: The 2014 USENIX Summit on Hot Topics in Security (HotSec '14) will be held on Tuesday, August 19, 2014, in conjunction with the 23nd USENIX Security Symposium in San Diego, CA. HotSec aims to bring together researchers across computer security disciplines to discuss the state of the art, with emphasis on future directions and emerging areas.
Information: http://www.usenix.org/conference/hotsec14.

* 19 **WOOT '14: 8th USENIX Workshop on Offensive Technologies**, Manchester Grand Hyatt, San Diego, California.
Description: Progress in the field of computer security is driven by a symbiotic relationship between our understandings of attack and of defense. The 8th USENIX Workshop on Offensive Technologies (WOOT .14) aims to bring together researchers and practitioners in systems security to present research advancing the understanding of attacks on operating systems, networks, and applications.
Information: http://www.usenix.org/conference/woot14.

19–21 **Advances in Applied Mathematics and Mathematical Physics**, Yildiz Technical University, Istanbul, Turkey. (Apr. 2014, p. 432)

* 20–22 **23rd USENIX Security Symposium**, Manchester Grand Hyatt, San Diego, California.
Description: The USENIX Security Symposium brings together researchers, practitioners, system administrators, system programmers, and others interested in the latest advances in the security of computer systems and networks. The Symposium includes a technical program with refereed papers, invited talks, posters, panel discussions, and Birds-of-a-Feather sessions. Workshops will precede the Symposium on August 18 and 19.
Information: http://www.usenix.org/conference/usenixsecurity14.

22–29 **Seventh International Conference on Differential and Functional Differential Equations**, Peoples' Friendship University of Russia, Moscow, Russia. (Jan. 2014, p. 92)

* 25–27 **The 39th Sapporo Symposium on Partial Differential Equations**, Room 203, Faculty of Science Building #5, Hokkaido University, Sapporo, Japan.
Description: The Sapporo Symposium on Partial Differential Equations has been held annually to present the latest developments on partial differential equations (PDE). The aim of the symposium is to help boost interaction and in-depth discussion among researchers working in mathematics, not limited to different branches of PDE. This symposium has been officially approved as a satellite conference of SeoulICM 2014. (http://www.icm2014.org/).
Organizers: H. Kubo (Hokkaido University), Y. Tonegawa (Hokkaido University). Program Committee: S. Ei (Hokkaido University), Y. Giga (The University of Tokyo), S. Jimbo (Hokkaido University), H. Kubo (Hokkaido University), T. Ozawa (Waseda University), T. Sakajo (Kyoto University), H. Takaoka (Hokkaido University), Y. Tonegawa (Hokkaido University), K. Tsutaya (Hirosaki University).
Contact: Symposium Secretariat: cri@math.sci.hokudai.ac.jp.
Information: http://www.math.sci.hokudai.ac.jp/sympo/sapporo/program140825_en.html.

25–28 **3rd International Eurasian Conference on Mathematical Sciences and Applications**, The Vienna University of Technology, Vienna, Austria. (Mar. 2014, p. 315)

* 25–28 **2014 Workshop for Young Researchers in Mathematical Biology**, Mathematical Biosciences Institute, The Ohio State University, Jennings Hall 3rd Floor, 1735 Neil Ave., Columbus, Ohio.
Description: The workshop is intended to broaden the scientific perspective of young researchers (primarily junior faculty, postdocs, and senior graduate students) in mathematical biology and to encourage interactions with other scientists. Workshop activities include plenary talks and poster sessions, as well as group discussions on issues relevant to mathematical biologists. Several abstracts will be chosen for short talks as well as to be presented as a poster. We cordially invite young mathematical biologists to participate.
Deadline: For full consideration, please apply by May 1, 2014.
Information: http://mbi.osu.edu/event/?id=827; phone: 614-292-3648.

* 25–29 **Exact Solvability and Symmetry Avatars: To celebrate Professor Luc Vinet's 60th birthday**, Centre de recherches mathématiques, Université de Montréal, Pavillon André-Aisenstadt, 2920, Chemin de la tour, 5th floor, Montréal (Québec), H3T 1J4 Canada.
Description: Integrable systems, both classical and quantum, share properties that make them easier to describe and study. It is therefore natural that many efforts are devoted to their study and that they found applications in diverse parts of mathematics and science: algebraic combinatorics, field and string theory, quantum information, orthogonal polynomials and special functions. The meeting will gather scientists from this broad horizon. It will also be the occasion to celebrate Professor Luc Vinet's 60th birthday. His scientific work has had a profound impact on many of the fields where integrability occurs.
Information: http://www.crm.umontreal.ca/2014/Vinet60/venue_e.php.

25–29 **First Brazilian Workshop in Geometry of Banach Spaces BWB 2014**, Maresias Beach Hotel, Maresias (Sao Sebastio), Brazil. (Jan. 2014, p. 92)

25–29 **Integrability and Cluster Algebras: Geometry and Combinatorics**, Brown University (ICERM), Providence, Rhode Island. (Jan. 2014, p. 92)

25–29 **Research School on Algebraic Lie Theory**, University of Glasgow, Glasgow, Scotland. (Apr. 2014, p. 432)

25–30 **19th International Summer School on Global Analysis and its Applications - "Symmetries"**, Lednice, Czech Republic Chateau Hotel, Lednice, Czech Republic. (Apr. 2014, p. 432)

* 25–September 5 **CIMPA-Indonesia School 2014 Mathematical and Statistical Tools in Mathematical Imaging**, Institut Teknologi Bandung, Bandung, Indonesia.
Description: The aim of this CIMPA School is to train postgraduate (Master/Ph.D.) students and postdocs in research activity in areas of Inverse Problem (IP). The proposed topics include areas which are currently active and the School intends to initiate the participants in working together doing research lead by some active researchers in the area of Inverse Problem.
Objective: The objectives of the school are: Introduce the participants to active areas in Inverse Problem and Imaging; provide the

student participants with the necessary tools to do research in Inverse Problem for their graduate work; provide early career researchers with sufficient knowledge and background to start their research in Inverse Problem; facilitate contacts with prominent mathematician working in Inverse Problem and the budding mathematicians interested in Inverse Problem coming to the School.
Information: http://cimpaimagingschool2014.fmipa.itb.ac.id.

* 25, 2014–April 27, 2015 **MBI Emphasis Year on Cancer and its Environment 2014-2015**, Mathematical Biosciences Institute, The Ohio State University, Jennings Hall 3rd Floor, 1735 Neil Ave., Columbus, Ohio.
Description: Cancer is one of the world's biggest killers – an evolutionary disease, where rounds of mutation and selection drive the emergence of a tumor. The complex interactions at the molecular, cellular and tissue levels emphasize the need and opportunity for mathematical models that synthesize a framework for understanding the existing phenomena and that make testable predictions as to how interventions will influence the outcome. This yearlong program will encompass many processes involved in cancer initiation and progression. Each workshop will concentrate on aspects of the disease, and there will be strong connections among the workshops.
Information: http://mbi.osu.edu/programs/emphasis-programs/future-programs/cancer-and-its-environment-2014-2015/.

25–September 5 **NATO Advanced Study Institute: Arithmetic of Hyperelliptic Curves and Cryptography**, University for Information Science and Technology "St. Paul the Apostle", Ohrid, Macedonia.

26–30 **The 10th William Rowan Hamilton Geometry and Topology Workshop on Homological Invariants in Low-dimensional Topology and Geometry**, The Hamilton Mathematics Institute, Trinity College Dublin, Ireland. (May 2014, p. 555)

* 28–29 **Connections for Women: Geometric Representation Theory**, Mathematical Sciences Research Institute, Berkeley, California.
Description: Within the broad range of geometric representation theory the Connections Workshop will focus on three research topics in which we expect particularly striking new developments within the next few years: Categorical and geometric structures in representation theory and Lie superalgebras; Geometric construction of representations via Shimura varieties and related moduli spaces; Hall algebras and representations. The workshop will bring together researchers from these different topics within geometric representation theory and will thus facilitate a successful start of the semester program. It will give junior researchers from each of these parts of geometric representation theory a broader picture of possible applications and of new developments, and will establish a closer contact between junior and senior researchers. This workshop is aimed at encouraging and increasing the active participation of women and members of underrepresented groups in the MSRI program.
Information: http://www.msri.org/workshops/706.

* 28–September 1 **International Workshop "Enveloping algebras and representation theory"**, Memorial University of Newfoundland, St. John's, NL, Canada.
Description: The aim of this workshop is to discuss the current state of research in the area of Enveloping Algebras and their applications, primarily in Representation Theory.
Invited speakers: Alberto Elduque (University of Zaragoza, Spain); Vyacheslav Futorny (University of Sao Paulo, Brazil); Victor Kac (Massachusetts Institute of Technology); Antony Joseph (Weizmann Institute, Israel); Vladimir Mazorchuk (University of Uppsala, Sweden); José María Pérez Izquierdo (University of La Rioja, Spain); Alexander Premet (University of Manchester, UK); Ivan Shestakov (University of Sao Paulo, Brazil); Sudarshan Sehgal (University of Alberta).
Information: http://www.mun.ca/aac/Workshops/NextWork/EART14First.pdf.

* 31–September 2 **The second International Symposium on Mathematical Biology (SYMOMATH 2014)**, Brawijaya University, Malang, East Java, Indonesia.
Description: SYMOMATH 2014 is a multidisciplinary meeting for the enhancement of scientific exchange of collaborations between researchers, students and industrial practitioners, who develop and apply mathematical, statistical and computational tools for understanding phenomena in various fields of biology, medicine, epidemiology, pharmacology, ecology, biotechnology, bioengineering, environmental sciences, etc. Selected papers (which are subject to a full review process) of SYMOMATH2014 will be published by 1. American Institute of Physics (AIP) Conference Proceeding Series (indexed in SCOPUS). 2. Applied Mathematical Sciences (indexed in SCOPUS and other databases).
Information: http://matematika.ub.ac.id/symomath/.

September 2014

1–5 **International School on Mathematical Epidemiology-ISME 2014**, Strathmore University, Nairobi, Kenya. (May 2014, p. 555)

1–December 19 **Trimester program on Non-commutative Geometry and its Applications**, Hausdorff Research Institute for Mathematics, Bonn, Germany. (Nov. 2013, p. 1399)

2–5 **Black-Box Global Optimization: Fast Algorithms and Engineering Applications (part of the CST2014 Conference)**, Hotel Royal Continental, Naples, Italy. (Mar. 2014, p. 315)

2–5 **Introductory Workshop: Geometric Representation Theory**, Mathematical Sciences Research Institute, Berkeley, California. (Sept. 2013, p. 1112)

2–5 **NUMAN2014 Recent Approaches to Numerical Analysis: Theory, Methods and Applications**, Chania, Crete, Greece. (Feb. 2014, p. 214)

2–7 **12th AHA Conference-Algebraic Hyperstructures and its Applications**, Democritus University of Thrace, School of Engineering, Department of Production and Management Engineering 67100, Xanthi, Greece International Algebraic Hyperstructures Association (IAHA). (Oct. 2013, p. 1204)

3–5 **4th IMA Numerical Linear Algebra and Optimisation**, University of Birmingham, Birmingham, United Kingdom. (Apr. 2014, p. 432)

3–5 **International Workshop on Operator Theory 2014 (iWOP2014)**, Queen's University Belfast, Belfast, Northern Ireland. (Mar. 2014, p. 316)

* 3–5 **Workshop on Finite Type Submanifolds**, Istanbul Technical University, Istanbul, Turkey.
Description: We aim to discuss the recent process on the theory of submanifolds; in particular, finite type mappings and finite type submanifolds. We will have invited talks and also some short talks on this topic. The invited talks will last 30 minutes plus 10 minutes for question and discussion. Short talks will last 15 minutes plus 7 minutes for question and discussion. In general, we want the speaker to give more details than a 15 minute plus regular talk in a symposium, because the workshop is aiming for the participiants who are related with this topic.
Information: http://www.matmuh.itu.edu.tr/Icerik.aspx?sid=12826.

5–6 **Symposium on Trustworthy Global Computing**, Rome, Italy. (Mar. 2014, p. 316)

* 7–12 **Workshop on "Exceptional Orthogonal Polynomials and Exact Solutions in Mathematical Physics"**, Segovia, Spain.
Description: Exceptional orthogonal polynomials are dense families of Sturm-Liouville orthogonal polynomials with gaps in their degree sequence. They appear as eigenfunctions of rational extensions of exactly solvable potentials in quantum mechanics, and they are

related to Darboux transformations and bispectrality in the theory of integrable systems. The past five years have seen a considerable activity in this field and we feel the time is ripe for bringing together many of the scientists who have contributed to this development, and others who might be interested in them.
Invited speakers: ∗ to be confirmed: Alexander P. Veselov (Loughborough University, UK), Robert Milson (Dalhousie University, Canada), Antonio Durán (Universidad de Sevilla, Spain), Alexei Zhedanov∗ (Donetsk Institute for Physics and Technology, Ukraine), Ryu Sasaki (Kyoto University, Japan), Luc Vinet (Centre de Recherches Mathématiques, Canada), Peter Clarkson (University of Kent, UK), Manuel Mañas (Universidad Complutense, Spain), Boris Shapiro∗ (Stockholm University, Sweden), Lance Littlejohn (Baylor University, United States).
Grants: There will be a limited number of grants for younger participants. Details on how to apply will be given in the website.
Information: Check the website below for detailed information on the scientific program, venue, sponsors, organizing committees, invited speakers, key dates and deadlines for abstract submissions is available, and will be updated in real time. http://www.icmat.es/congresos/2014/xopconf/.

8–11 **CICAM 7, Seventh China-Italy Colloquium on Applied Mathematics**, Palermo, Italy. (May 2014, p. 555)

8–12 **Workshop on Special Geometric Structures in Mathematics and Physics**, University of Hamburg, Hamburg, Germany.

* 8–December 5 **ICERM Semester Program: High-Dimensional Approximation**, Brown University, Providence, Rhode Island. (May 2014, p. 555)
Description: This program addresses a broad spectrum of approximation problems, from the approximation of functions in norm, to numerical integration, to computing minima, with a focus on sharp error estimates. It will explore the rich connections to the theory of distributions of point-sets in both Euclidean settings and on manifolds and to the computational complexity of continuous problems. It will address the issues of design of algorithms and of numerical experiments. The program will attract researchers in approximation theory, compressed sensing, optimization theory, discrepancy theory, and information based complexity theory.
Information: http://icerm.brown.edu/sp-f14/.

8–December 12 **Mathematics of Turbulence**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California. (Oct. 2013, p. 1204)

* 9–12 **Summer School on Spectral Geometry**, University of Göttingen, Göttingen, Germany.
Description: This school event is jointly organized by the Research Training Groups "Mathematical Structures in Modern Quantum Physics" (http://www.uni-goettingen.de/en/139006.html) in Göttingen and "Analysis, Geometry and String Theory" (http://www.grk1463.uni-hannover.de) in Hannover. It will give current and prospective Ph.D. students an introduction to the fascinating subject of spectral geometry, with an emphasis on microlocal techniques. A particular focus will be on parabolic and hyperbolic methods in spectral geometry, while also a discussion of analytic torsion and of spectral zeta functions is offered. Participants will have an opportunity to present a poster.
Funding: Is available to a limited number of Ph.D. students.
Information: http://www.uni-math.gwdg.de/SpecGeo2014/.

10–12 **IMA Conference on Mathematical Modelling of Fluid Systems**, University of Bath, United Kingdom. (May 2014, p. 555)

11–13 **Second International Conference on Analysis and Applied Mathematics (ICAAM 2014)**, M. Auezov South Kazakhstan State University, Shymkent, Kazakhstan. (Apr. 2014, p. 432)

* 14–18 **Getting Started with PDE - Summer Workshop for Undergraduate and Graduate Students**, Department of Mathematics, Technion - I.I.T., 32000 Haifa, Israel.
Description: The workshop's aim is to introduce undergraduate and graduate students in Mathematics, Science, and Engineering to a variety of subjects of current research in Partial Differential Equations and Applied Mathematics. The only required prerequisite is a basic undergraduate course in Partial Differential Equations. Four mini-courses will be given, by Xavier Cabre (Barcelona), Ross Pinsky (Technion), Jean-Michel Roquejoffre (Toulouse), and Koby Rubinstein (Technion). In addition, outreach lectures will be given by Ram Band (Technion), Haim Brezis (Rutgers University & Technion), Dan Mangoubi (Hebrew University), and Lenya Ryzhik (Stanford).
Information: http://www.math.technion.ac.il/cms/decade_2011-2020/year_2013-2014/PDE-workshop/.

15–19 **AIM Workshop: Generalized persistence and applications**, American Institute of Mathematics, Palo Alto, California. (Apr. 2014, p. 432)

* 15–19 **ICERM Semester Program Workshop: Information-Based Complexity and Stochastic Computation**, Brown University, Providence, Rhode Island.
Description: Topics covered in the workshop will include: adaptive and nonlinear approximation for SPDEs, infinite-dimensional problems, inverse and ill-posed problems, quasi-Monte Carlo methods, PDEs with random coefficients, sparse/Smolyak grids, stochastic multi-level algorithms, SDEs and SPDEs with nonstandard coefficients, tractability of multivariate problems. This workshop will bring together researchers from these different fields. The goal is to explore connections, learn and share techniques, and build bridges.
Information: http://icerm.brown.edu/sp-f14-w1/.

* 15–19 **Workshop 1: Ecology and Evolution of Cancer**, Mathematical Biosciences, Institute The Ohio State University, Jennings Hall 3rd Floor, 1735 Neil Ave., Columbus, Ohio.
Description: This workshop will bring together cancer researchers and mathematical oncologists as well as ecologists with the aim of understanding how ecological principles can be used to understand cancer, how the mathematical tools used by theoretical ecologists could be used to gain new insights in cancer research and what principles of ecological management could be used to produce new therapies to treat cancer in the clinic.
Information: http://mbi.osu.edu/event/?id=495; phone: 614-292-3648.

* 17–20 **Joint Meeting of the German Mathematical Society (DMV) and the Polish Mathematical Society (PTM)**, The Faculty of Mathematics and Computer Science of the Adam Mickiewicz University, Campus UAM, Morasko, 61-616 Poznań, Poland.
Description: The meeting is a joint initiative of the Polish Mathematical Society (Polskie Towarzystwo Matematyczne) and the German Mathematical Society (Deutsche Mathematiker-Vereinigung). Mathematicians from other countries are also cordially invited to participate. There are 10 plenary lectures, 38 thematic sessions, an open general session "Contributed Talks", and the poster session.
Plenary speakers: Zbigniew Błocki (UJ, Kraków), Joachim Escher (Univ. Hannover), Friedrich Götze (Univ. Bielefeld), Joachim Hilgert (Univ. Paderborn), Grzegorz Karch (Univ. Wrocław), Adrian Langer (Univ. Warszawa), Tomasz Schoen (UAM Poznań), Katrin Tent (Univ. Münster), Barbara Wohlmut (Tech. Univ. München), Grzegorz Zwara (UMK, Toruń).
Information: For more information and for the program of the meeting as it becomes progressively available, please consult the webpage http://dmv.ptm.org.pl/.

17–20 **Third International Conference of Numerical Analysis and Approximation Theory (NAAT2014)**, Babes - Bolyai University, Faculty of Mathematics and Computer Science, Department of Mathematics, Cluj-Napoca, Romania. (Apr. 2014, p. 432)

18–20 **Riemann, Einstein and geometry**, Institut de Recherche Mathématique Avancée, University of Strasbourg, France. (Oct. 2013, p. 1204)

* 18–21 **The 22-nd Conference on Applied and Industrial Mathematics CAIM 2014**, University Vasile Alecsandri, Bacau, Romania.
Description: The sections of the conference are: Real, complex, functional and numerical analysis; partial differential equations with applications in mechanics, biology, etc.; ordinary differential equations, dynamical systems; probability theory, mathematical statistics, operation research; algebra, logic, geometry (with applications); mathematical modeling; computer science; education.
Information: http://www.romai.ro/conferintele_romai/caim2014_en.html.

20–21 **Sectional Meeting**, University of Wisconsin-Eau Claire, Eau Claire, Wisconsin. (Sept. 2013, p. 1112)

21–26 **12th International Conference of The Mathematics Education into the 21st Century Project: The Future of Mathematics Education in a Connected World**, Hunguest Hotel Sun Resort, Herceg Novi, Montenegro. (Dec. 2013, p. 1497)

* 22–25 **5th International Workshop on Computational Topology in Image Context**, Timisoara, Romania.
Description: The general aim of CTIC workshops is to gather researchers dealing with the study of topological invariants from the computational point of view, and/or who want to use topological information in image applications. The specific aim of CTIC 2014 is to focus on the interplay between various methods of image processing and in particular on multi-dimensional and multi-variate image processing and on the efficient application of these new techniques in medical imagery. The workshop intends to provide an opportunity for participants, from different fields related to computational geometry, discrete geometry, geometrical modeling, algebraic topology and image processing to exchange ideas.
Information: http://ctic2014.synasc.ro/.

* 22–25 **Workshop on Statistical Inference for Lévy Processes**, Lorentz Center, Leiden, The Netherlands.
Invited speakers: Denis Belomestny; Loïc Chaumont; José Manuel Corcuera; Valentine Genon-Catalot; Marc Hoffmann; Jean Jacod; Cecilia Mancini; Yuliya Mishura; Antonis Papapantoleon; Philip Protter; Markus Reiß; Viktor Todorov; Mathias Vetter.
Registration: There is no registration fee, but the number of participants is limited. For more information, particularities and registration, see the website.
Information: http://tinyurl.com/ph86pbw.

* 22–26 **Boston University/Keio University workshop on Dynamical Systems**, Boston University, Boston, Massachuetts.
Description: This is the fourth in a series of annual workshops run jointly by Boston University (US) and Keio University (Japan) and aimed at exposing young researchers to topics of interest in the two departments. This year's focus will be Dynamical Systems, and the talks will be accessible to graduate students in that area. Morning sessions will involve talks by faculty, and afternoon sessions will involve talks by graduate students and postdocs. NSF funding is available to partially support the participation of graduate students and those whose Ph.D. was awarded in 2011 or later.
Information: http://math.bu.edu/keio2014/index.html.

* 22–26 **Logic and Applications - LAP 2014**, Inter-University Center, Dubrovnik, Croatia.
Description: The conference brings together researchers from various fields of logic with applications in computer science.
Topics: Of interest include, but are not restricted to: Formal systems of classical and non-classical logic, category theory, proof theory, lambda calculus; type theory; process algebras and calculi; behavioural types, systems of reasoning in the presence of incomplete, imprecise and/or contradictory information, computational complexity, interactive theorem provers. Student sessions will be organized. The first conference Proof Systems: Sustavi dokazivanja was held in Dubrovnik on June 28, 2012, co-located with the conference LICS 2012. The second conference Logic and Applications 2013: LAP 2013 was held in Dubrovnik, September 16–20, 2013.
Information: http://imft.ftn.uns.ac.rs/math/cms/LAP2014.

* 22–30 **Summer school and conference on Finsler geometry and it applications**, University of the Aegean, Island of Samos, Greece.
Description: Summer school and conference on Finsler geometry and its applications, including metric geometry and Teichmüller theory. Ph.D. students and young researchers are welcome. There will be a series of courses given by Norbert A'Campo (Basel), Dimitri Burago (Penn State), Yuri Burago (Moscow), Bill Goldman (Maryland), Olivier Guichard (Strasbourg), Viktor Schroeder (Zürich), and Sumio Yamada (Tokyo). There will also be talks by other participants.
Registration: There is no registration fee and the organizers will help in finding lodging in Samos during the conference. To register, contact the organizers A. Papadopoulos and G. Tsapogas, email: papadop@math.unistra.fr and email: georgios.tsapogas@gmail.com.
Information: http://myria.math.aegean.gr/conferences/finsler14/.

23–25 **3rd International Conference on Mathematical Applications in Engineering 2014**, Kuala Lumpur, Malaysia. (Mar. 2014, p. 316)

* 29–October 1 **MBI Boot Camp: How to Simulate and Analyze Your Cancer Models with COPASI**, Mathematical Biosciences Institute, The Ohio State University, Jennings Hall 3rd Floor, 1735 Neil Ave., Columbus, Ohio.
Description: Mathematical models typically start out in simple form. One writes down a few differential equations, estimates the parameters, explores the output, and checks to see if it can predict behavior reasonably well. After that, the process begins to take on a life of its own. Since the model is greatly abstracted and simplified, it captures some aspects of the system, but fails in others, so new variables and more inputs are added. Alternative mechanisms are investigated. At some point, the question arises: How can one tell if this is a good model?
Aim: The aim of this bootcamp is to provide tools that provide good cancer models. We will frame the question in a way that respects both the biology and the underlying mathematics. Two organizers of the bootcamp, Pedro Mendes and Stefan Hoops, have spent the last twenty years creating a bridge between these paradigms, in the form of a software package called COPASI (COmplex PAthway SImulator). COPASI is a simulation software that allows one to translate the biochemical interactions between species into dynamical systems represented by the sets of either stochastic or deterministic equations. COPASI developers have created a user-friendly graphical interface, which can help researchers to apply sophisticated analytical tools to their models. This workshop provides an introduction to the ease and power of the software.
Information: http://mbi.osu.edu/event/?id=757; phone: 614-292-3648.

29–October 3 **AIM Workshop: Quantum curves, Hitchin systems, and the Eynard-Orantin theory**, American Institute of Mathematics, Palo Alto, California. (May 2014, p. 555)

* 29–October 3 **ICERM Semester Program Workshop: Approximation, Integration, and Optimization**, Brown University, Providence, Rhode Island.
Description: The workshop is devoted to the following problem of fundamental importance throughout science and engineering: how to approximate, integrate, or optimize multivariate functions. The workshop will bring together leading experts in approximation, compressed sensing and optimization.
Information: http://icerm.brown.edu/sp-f14-w2/.

29–October 3 **International Conference on Numerical and Mathematical Modeling of Flow and Transport in Porous Media**, Centre for Advanced Academic Studies (CAAS), 20000 Dubrovnik, Croatia. (Jan. 2014, p. 92)

October 2014

5–11 **International Conference on Algebraic Methods in Dynamical Systems (Conference in honour of the 60th birthday of Juan J. Morales-Ruiz)**, Universidad del Norte, Barranquilla, Colombia. (Jan. 2014, p. 92)

* 6–9 **Methods of Noncommutative Geometry in Analysis and Topology**, Leibniz University Hannover, Hannover, Germany.
Description: The event will gather experts in the noncommutative geometry community, with Kasparov's bivariant K-theory as the unifying theme. A focal point of the workshop will be the Baum-Connes conjecture, which for three decades has been a central problem in this field, bringing together geometry, topology, and analysis. This has lead to both new fundamental ideas as well as interactions with other fields of mathematics. Notable applications encompass index theory, mathematical physics, dynamical systems and the classification of C*-algebras. There will be a poster session to promote the interaction between junior researchers and experts in the field.
Information: http://www.math-conf.uni-hannover.de/methodsncg14/de/.

13–17 **AIM Workshop: Positivity, graphical models, and modeling of complex multivariate dependencies**, American Institute of Mathematics, Palo Alto, California. (Apr. 2014, p. 432)

* 13–17 **MBI Workshop 2: Metastasis and Angiogenesis**, Mathematical Biosciences Institute, The Ohio State University, Jennings Hall 3rd Floor, 1735 Neil Ave., Columbus, Ohio.
Description: This workshop will address the mathematical and computational issues that arise from models of angiogenesis and metastasis. Such models are frequently hybrid models, that describe cells (either those building the vessel or those involved in metastasis) at a detailed level that treats their biochemical and mechanical responses to their environment, and couple this cell-based description with partial differential equations that describe the mechanics of the surrounding tissue and the reaction and transport of growth factors and chemotactic signals. Major topics to be treated are how to model the movement of single cells through the extracellular matrix, how to describe in sufficient detail the process by which new vessels grow toward a tumor, how to cope with the computational problems raised by such hybrid models, and what the implications are for our understanding of the underlying basic science and how that understanding can be translated into improved therapeutic regimens.
Information: http://mbi.osu.edu/event/?id=496; phone: 614-292-3648.

* 17–19 **Georgia Algebraic Geometry Symposium 2014**, University of Georgia, Athens, Georgia.
Description: General conference on the latest topics in algebraic geometry.
Funding: Is available for graduate students and young researchers.
Speakers: Ana-Maria Castravet (Ohio), Christopher Hacon (Utah), Jun-Muk Hwang (KIAS, Seoul), Robert Lazarsfeld (Stony Brook), Diane Maclagan (Warwick, UK), Davesh Maulik (Columbia), Mircea Mustata (Michigan), Karl Schwede (Penn State).
Information: http://gags.torsor.org/conf2014/.

* 17–19 **Yamabe Memorial Symposium 2014: Current Topics in the Geometry of 3-Manifolds**, School of Mathematics, University of Minnesota, Minneapolis, Minnesota 55455
Description: The eight speakers will be: Ian Agol, UC Berkeley; Mladen Bestvina, Utah; Jeremy Kahn, CUNY-Graduate Center; Ursula Hammenstaedt, Bonn; Ciprian Manolescu, UCLA; Mahan Mj, RKM Vivekanda University, India; Vlad Markovic, Cambridge; Stefano Vidussi, UCRiverside.
Sponsor: The Symposium is sponsored by NSF with additional support from the UMN School of Math. and the Yamabe endowment.
Financial support: Is available, especially for grad students, postdocs, and young researchers. An application/registration form is on the Symposium website. Applicants who are members of the GEAR Network (see http://math.illinois.edu/GEAR/GEARNodes.pdf) or are grad students or postdocs associated with GEAR members may be able to use GEAR resources to facilitate Symposium attendance. For information see: http://gear/math.illinois.edu/programs.
Deadline: For applications for Symposium funding is Wednesday August 6, 2014. Later applications will be considered if funds allow. But all interested mathematician are invited to attend.
Information: http://www.math.umn.edu/yamabe/.

18–19 **Sectional Meeting**, Dalhousie University, Halifax, Canada. (Sept. 2013, p. 1112)

20–24 **Autumn school on nonlinear geometry of Banach spaces and applications**, Métabief, France.

22–24 **International Conference in Modeling Health Advances 2014**, UC Berkeley, San Francisco Bay Area, California. (Apr. 2014, p. 432)

22–24 **28th Midwest Conference on Combinatorics and Combinatorial Computing**, University of Nevada, Las Vegas (UNLV), Las Vegas, Nevada. (Feb. 2014, p. 214)

* 23–25 **The Tenth Mississippi State Conference on Differential Equations & Computational Simulations**, Mississippi State University, Starkville, Mississippi.
Description: This interdisciplinary conference will provide a joint forum where mathematicians, scientists and engineers from industries, federal laboratories and academia can exchange research and development ideas. An overall goal of this conference is to promote research and education in mathematical and computational analysis of theoretical and applied differential equations. In addition to the ten principal lectures, there will be sessions for twenty minute contributed talks. This conference is dedicated to Ratnasingham Shivaji in celebration of his 60th birthday, his outstanding contributions to differential equations, and his service to Mississippi State University. Conference participants are encouraged to submit full length manuscripts after the conference. Reviewed manuscripts will be published as a special issue of the *Electronic Journal of Differential Equations*.
Deadline: For pre-registration and abstract submission is September 5, 2014.
Information: http://www.ccs.msstate.edu/deconf/de2014/.

23–26 **Ahlfors-Bers Colloquium VI**, Yale University, New Haven, Connecticut. (Oct. 2013, p. 1204)

25–26 **Sectional Meeting**, San Francisco State University, San Francisco, California. (Sept. 2013, p. 1112)

27–31 **AIM Workshop: Configuration spaces of linkages**, American Institute of Mathematics, Palo Alto, California. (Apr. 2014, p. 433)

27–31 **Conference on Geometric Functional Analysis and its Applications**, Université de Franche-Comté, Besann, France.

* 27–31 **ICERM Semester Program Workshop: Discrepancy Theory**, Brown University, Providence, Rhode Island.
Description: The participants of this workshop will share a wide range of views on topics related to discrepancy with an eye towards the recent developments in the subject. The workshop will bring together different communities working on various aspects of discrepancy theory. The exchange of ideas and approaches, the cross-fertilization of viewpoints, sharing the visions of near and far term goals of the field will be the highlight of the conference.
Information: http://icerm.brown.edu/sp-f14-w3/.

November 2014

* 1–December 31 **Scalar Curvature in Manifold Topology and Conformal Geometry**, Institute for Mathematical Sciences, National University of Singapore, Singapore.
Description: The purpose of the program is to bring together researchers working on the areas to communicate ideas and dig out the connections as well as stimulate possible research collaboration. Activities 1. Workshop on Positive Curvature and Index Theory: November 17–21, 2014 2. Workshop on Partial Differential Equation and its Applications: December 8–12, 2014. 3. Winter School on Scalar Curvature and Related Problems: December 16–19, 2014. There will be four mini-courses. 4. Public Lecture.
Information: http://www2.ims.nus.edu.sg/Programs/014scalar/index.php.

3–7 **AIM Workshop: Combinatorics and complexity of Kronecker coefficients**, American Institute of Mathematics, Palo Alto, California. (Apr. 2014, p. 433)

* 3–7 **MBI Current Topic Workshop on Axonal Transport and Neuronal Mechanics**, Mathematical Biosciences Institute, The Ohio State University, Jennings Hall 3rd Floor, 1735 Neil Ave., Columbus, Ohio. (Apr. 2014, p. 433)
Description: The goal of this workshop is to bring together leading cell biologists, engineers, physicists, and mathematicians to openly discuss exciting new findings, long-standing questions, and the future of our field. The timeliness of this meeting and its relevance to the mission of the MBI is most evident from three recent reviews by the organizers (Bressloff and Newby, 2013; Franze et al., 2013; Suter and Miller, 2011). In brief these reviews discuss the emerging role of forces in axonal elongation, mathematical models that have been developed to study the contribution of axonal transport to elongation, and the importance of developing mathematical models to study neuromechanics.
Information: http://mbi.osu.edu/event/?id=817; phone: 614-292-3648.

5–8 **Fifth Ya.B. Lopatinskii International Conference of Young Scientists on Differential Equations and Its Applications**, Donetsk National University, Donetsk, Ukraine. (Mar. 2014, p. 316)

* 6–9 **International Conference on Recent Advances in Pure and Applied Mathematics (ICRAPAM 2014)**, Club Sera Hotel, Antalya, Turkey.
Description: ICRAPAM 2014 is an international forum for mathematicians, scientists and engineers to present their latest research and development results in all areas of Pure and Applied Mathematics and their possible advanced applications in real life. The Conference has a distinguished Organizing Committee and Scientific Committee with extensive academic qualifications, ensuring that the conference maintains high scientific standards and has a broad international coverage. All the papers are subject to rigorous peer-review by at least two members of scientific committee or additional reviewers. The technical program will consist of keynote speakers by eminent specialists, oral presentation of the contributed papers and posters of the work-in-progress. Full versions of the accepted abstracts will be published in the journals listed on the conference website.
Information: http://www.icrapam.org.

8–9 **Sectional Meeting**, University of North Carolina, Greensboro, North Carolina. (Sept. 2013, p. 1112)

* 9–14 **LISA '14: 28th Large Installation System Administration Conference**, Sheraton Seattle Hotel, Seattle, Washington.
Description: USENIX's Large Installation System Administration (LISA) conference — now in its 28th year — is the premier meeting place for professionals who make computing work across a variety of industries. If you.re an IT operations professional, site-reliability engineer, system administrator, architect, software engineer, researcher, or otherwise involved in ensuring that IT services are effectively delivered to others — this is your conference, and we'd love to have you here.
Information: http://www.usenix.org/conference/lisa14.

11–January 25 **Inverse Moment Problems: The Crossroads of Analysis, Algebra, Discrete Geometry and Combinatorics**, Institute for Mathematical Sciences, National University of Singapore, Singapore. (Sept. 2013, p. 1112)

13–15 **SIAM Conference on Financial Mathematics and Engineering (FM14)**, The Palmer House, A Hilton Hotel, Chicago, Illinois. (May 2014, p. 555)

14–17 **Conference on Mathematics and its Applications-2014**, Kuwait University, Kuwait City, Kuwait. (May 2014, p. 555)

17–21 **AIM Workshop: Bounded gaps between primes**, American Institute of Mathematics, Palo Alto, California. (May 2014, p. 556)

* 17–21 **Categorical Structures in Harmonic Analysis**, Mathematical Sciences Research Institute, Berkeley, California.
Description: The workshop will focus on the role of categorical structures in number theory and harmonic analysis, with an emphasis on the setting of the Langlands program. Celebrated examples of this theme range from Lusztig's character sheaves to Ngo's proof of the Fundamental Lemma. The workshop will be a forum for researchers from a diverse collection of fields to compare problems and strategies for solutions.
Information: http://www.msri.org/workshops/708.

* 17–21 **MBI Workshop on Cancer and the Immune System**, Mathematical Biosciences Institute, The Ohio State University, Jennings Hall 3rd Floor, 1735 Neil Ave., Columbus, Ohio.
Description: The present workshop will bring together cancer biologists and mathematical modelers to review the state of present knowledge and explore future directions. It will also provide an environment that will encourage communication and new contacts among the biologists and mathematicians. Formal lecture and informal discussions will articulate future directions where mathematical models can significantly enhance understanding of the complex relations between tumor cells and the immune cells, and suggest novel approaches to therapy.
Information: http://mbi.osu.edu/event/?id=498; phone: 614-292-3648.

* 24–28 **International Conference on Pure and Applied Mathematics, Goroka 2014: ICPAM-GOROKA (2014)**, University of Goroka, Goroka, Eastern Highlands Province, Papua, New Guinea.
Description: ICPAM-GOROKA 2014, aims at bringing together experts in different fields of pure and applied mathematics, as well as researchers, undergraduates and postgraduate students from around the world to discuss mathematical questions, exchange high level knowledge of methods and investigate diverse applications of Pure and Applied Mathematics to astronomy, biology, business, banking, chemistry, computer science, education, engineering, geosciences, health care, medicine, physics, security, the military, etc. Academia and industries are invited to participate.
Information: http://icpam-goroka2014.blogspot.com.

26–29 **International Congress on Music and Mathematics**, University of Guadalajara, Puerto Vallarta, Mexico. (May 2014, p. 556)

26–30 **The 19th Asian Technology Conference in Mathematics (ATCM 2014)**, State University of Yogyakarta, Yogyakarta, Indonesia.

27–29 **Annual meeting of the French research network (GdR) in Noncommutative Geometry**, Besancon, France. (Mar. 2014, p. 317)

December 2014

* 1–5 **AIM Workshop: Beyond Kadison-Singer—paving and consequences**, American Institute of Mathematics, Palo Alto, California.

Description: This workshop, sponsored by AIM and the NSF, will be devoted to broadening the recent proof of the Kadison-Singer Problem and to exploring its consequences.
Information: http://aimath.org/workshops/upcoming/beyondks.

1–5 **38th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing (ACCMCC)**, Victoria University of Wellington, Wellington, New Zealand. (Mar. 2014, p. 317)

* 1–5 **Automorphic forms, Shimura varieties, Galois representations and L-functions**, Mathematical Sciences Research Institute, Berkeley, California.
Description: L-functions attached to Galois representations coming from algebraic geometry contain subtle arithmetic information (conjectures of Birch and Swinnerton-Dyer, Deligne, Beilinson, Bloch and Kato, Fontaine and Perrin-Riou). Langlands has predicted the existence of a correspondence relating these L-functions to L-functions of automorphic forms which are much better understood. The workshop will focus on recent developments related to Langlands correspondence (construction of Galois representations attached to automorphic forms via the cohomology of Shimura varieties, modularity of Galois representations...) and arithmetic of special values of L-functions. It will be dedicated to Michael Harris as a tribute to his enormous influence on the themes of the workshop.
Information: http://www.msri.org/workshops/719.

1–5 **International Conference on Applied Mathematics — in honour of Professor Roderick S. C. Wong's 70th Birthday**, City University of Hong Kong, Tat Chee Avenue, Kowloon Tong, Hong Kong. (May 2014, p. 556)

1–12 **Winter School on Operator Spaces, Non-commutative Probability and Quantum Groups**, Métabief, France. (Feb. 2014, p. 214)

6–31 **The Info-Metrics Annual Prize in Memory of Halbert L. White Jr.**, Washington, DC. (Feb. 2014, p. 214)

* 8–10 **IMA Conference on Game Theory and its Applications**, St. Anne's College, Oxford, United Kingdom.
Topics: Include the following and are invited to be presented in oral and poster sessions: Search Games with Human and Animal Agents; Equilibrium Computation; Game Theory for Sustainability; Game Theory and Cyber-Security; Game Theory for Auctions and Markets; Gameification.
Call for Papers: Papers will be accepted for the conference based on a 500-word abstract for oral or poster presentation. Abstracts should be submitted by Friday, September 5, 2014 by e-mail to: conferences@ima.org.uk. Successful authors will be notified by Friday, September 26, 2014. Please state whether your title is intended for oral or poster presentation.
Organizing Committee: Rahul Savani (University of Liverpool)–Chair; Steve Alpern (Warwick University), Co-chair; Dragan Pleskonjic (GTECH); Gopal Ramchurn (University of Southampton).
Information: http://ima.org.uk/conferences/conferences_calendar/game_theory_and_its_applications.html.

8–12 **AIM Workshop: Transversality in contact homology**, American Institute of Mathematics, Palo Alto, California. (May 2014, p. 556)

8–12 **8th Australia – New Zealand Mathematics Convention**, University of Melbourne, Melbourne, Australia. (Apr. 2014, p. 433)

9–10 **First call for the training programme "Collaborative Mathematical Research"**, Centre de Recerca Matematica, Bellaterra, Barcelona, Spain. (Mar. 2014, p. 317)

9–19 **Recent Advances in Operator Theory and Operator Algebras-2014**, Bangalore, India. (Dec. 2013, p. 1497)

* 9–20 **Vertex algebras, W-algebras, and applications**, Centro di Ricerca Matematica Ennio De Giorigi, Pisa, Italy.
Description: In Winter 2014-2015, a trimester on "Perspectives in Lie Theory" will be held at Centro de Giorgi. The first session of this trimester will be devoted to "Vertex algebras, W-algebras, and applications". This session will include a seminar, time for discussions and collaboration, and three minicourses held by Tomoyuki Arakawa (Kyoto University), Victor Kac (MIT), and Fedya Malikov (University of Southern California). http://www.crm.sns.it/event/293/. More information can be found at: http://www.crm.sns.it/event/293/activities.html#title.

11–20 **Foundations of Computational Mathematics Conference**, Universidad de la República, Montevideo, Uruguay. (Feb. 2014, p. 214)

* 15–17 **10th IMA International Conference on Mathematics in Signal Processing**, Austin Court, Birmingham, United Kingdom.
Description: Signal processing constitutes an important area for the application of mathematical concepts and techniques fuelled, for example, by developments in mobile communications, networks, multimedia system, genomics and bioengineering, neural signal processing, and big data processing. The subject is still advancing rapidly in areas such as non-linear signal processing and systems, compressive sampling, digital communication systems, iterative estimation, blind deconvolution/signal separation, broadband systems, compressed sensing and novel sampling schemes. The aim of the conference is to bring together mathematicians, statisticians and engineers with a view to exploring recent developments and identifying fruitful avenues for further research. It is hoped that the meeting will help to attract more mathematicians into this important and challenging field.
Information: http://www.ima.org.uk/.

* 16–17 **1st International Conference on Security Standardisation Research**, Royal Holloway, University of London (RHUL), Egham Hill, Egham, United Kingdom.
Description: Over the last two decades a very wide range of standards have been developed covering a wide range of aspects of cyber security. These documents have been published by national and international formal standardisation bodies, as well as by industry consortia. Many of these standards have become very widely used. Despite their wide use, there will always be a need to revise existing security standards and to add new standards to cover new domains. The purpose of this conference is to discuss the many research problems deriving from studies of existing standards, the development of revisions to existing standards, and the exploration of completely new areas of standardisation. This conference is intended to cover the full spectrum of research on security standard.
Information: http://www.ssr2014.com.

19–21 **International Conference on Current Developments in Mathematics and Mathematical Sciences (ICCDMMS-2014)**, Calcutta Mathematical Society, AE-374, Sector-1, Salt Lake City, Kolkata-700064 West Bengal, India. (Apr. 2014, p. 433)

19–21 **2014 Fourth International Conference on Emerging Applications of Information Technology (EAIT 2014)**, Indian Statistical Institute, Kolkata, India. (May 2014, p. 556)

* 21–23 **8th International Conference of IMBIC on "Mathematical Sciences for Advancement of Science and Technology (MSAST 2014)"**, IMBIC, Salt Lake City, Kolkata, India.
Description: The main objective of the conference is to bring specialized topics in mathematics, statistics, computer science, information technology, bioinformatics, and closely related interdisciplinary areas to the forefront. Original full papers are invited. All papers are to be screened and accepted papers will be published in the *Proceedings of IMBIC*, Volume 3 (2014), having ISBN 978-81-925832-2-8, except for a few full scientific papers of high quality, which may be published in the highly acclaimed series of monographs of IMBIC. Many scientists from India, USA, Japan, Canada, Sweden, France,

Germany, Finland, Australia, Russia, Egypt, Mexico, Algeria, Botswana, Korea, South Africa, and many other countries participated in the earlier conferences.
Contact: All correspondences in respect to the conference are to be addressed to Dr. Avishek Adhikari, Convenor MSAST 2014 & Secretary, IMBIC; email: msast.paper@gmail.com; http://www.isical.ac.in/~avishek_r/.
Information: http://www.imbic.org/forthcoming.html.

January 2015

* 1–March 31 **High Performance and Parallel Computing for Materials Defects and Multiphase Flows**, Institute for Mathematical Sciences, National University of, Singapore, Singapore.
Description: The program activities will consist of three workshops, tutorial lectures, public lectures, working seminars, and collaborative research. 1. Collaborative Research: January 1–March 31, 2015. 2. Workshop I: January 12–16, 2015. Title: Recent Advances in Parallel and High Performance Computing Techniques and Applications 3. Workshop II: February 9–13, 2015. Title: High Performance and Parallel Computing Methods and Algorithms for Materials Defects 4. Workshop III: March 2–6, 2015. Title: High Performance and Parallel Computing Methods and Algorithms for Multiphase/Complex Fluids. 5. Tutorial and Public Lectures—Distinguished researchers will give tutorial and public lectures on topics in high performance and parallel computing with applications in material defects and complex fluids.
Information: http://www2.ims.nus.edu.sg/Programs/015hiper/index.php.

4–6 **ACM-SIAM Symposium on Discrete Algorithms (SODA15), being held with Analytic Algorithmics and Combinatorics (ANALCO15) and Algorithm Engineering and Experiments (ALENEX15)**, The Westin Gaslamp Quarter, San Diego, California. (Feb. 2014, p. 214)

* 5–9 **AIM Workshop: Tumor-immune dynamics**, American Institute of Mathematics, Palo Alto, California.
Description: This workshop, sponsored by AIM and the NSF, will be devoted to mathematical and computational modeling of tumor-immune dynamics.
Information: http://aimath.org/workshops/upcoming/tumorimmune2.

5–June 26 **Periodic and Ergodic Spectral Problems**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom. (Mar. 2013, p. 365)

12–May 22 **Dynamics on Moduli Spaces of Geometric Structures Program**, Mathematical Sciences Research Institute, Berkeley, California. (Jan. 2014, p. 117)

12–July 3 **Random Geometry**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom. (Mar. 2013, p. 365)

* 15–16 **Connections for Women: Dynamics on Moduli Spaces of Geometric Structures**, Mathematical Sciences Research Institute, Berkeley, California.
Description: This two-day workshop will consist of short courses given by prominent female mathematicians in the field. These introductory courses will be appropriate for graduate students, postdocs, and researchers in areas related to the program. The workshop will also include a panel discussion featuring successful women at various stages in their mathematical careers.
Information: http://www.msri.org/workshops/739.

* 19–February 6 **Lie Theory and Representation Theory**, Centro di Ricerca Matematica Ennio De Giorigi, Pisa, Italy.
Description: In Winter 2014-2015, a trimester on "Perspectives in Lie Theory" will be held at Centro de Giorgi. The second session of this trimester will be devoted to the topic "Lie Theory and Representation Theory". This session will include a seminar, time for discussions and collaboration, and three minicourses held by Alexander Premet (University of Manchester), Vera Serganova (University of California, Berkeley) and Geordie Williamson (Max-Planck-Institute, Bonn).
Information: http://www.crm.sns.it/event/293/. More information can be found at: http://www.crm.sns.it/event/293/activities.html#title.

* 20–23 **Introductory Workshop: Dynamics on Moduli Spaces of Geometric**, Mathematical Sciences Research Institute, Berkeley, California.
Description: The deformation theory of geometric structures on manifolds is a subfield of differential geometry and topology, with a heavy infusion of Lie theory. Its richness stems from close relations to dynamical systems, algebraic geometry, representation theory, Lie theory, partial differential equations, number theory, and complex analysis. The introductory workshop will serve as an overview to the program. It aims to familiarize graduate students, post-docs, and other researchers to the major topics of the program. There will be a number of short courses.
Information: http://www.msri.org/workshops/740.

* 26–30 **AIM Workshop: Graph Ramsey Theory**, American Institute of Mathematics, Palo Alto, California.
Description: This workshop, sponsored by AIM and the NSF, will be devoted to graph Ramsey theory. The main topics of the workshop are Hypergraph Ramsey numbers, Generalized Ramsey numbers, and Geometric Ramsey theorems.
Information: http://aimath.org/workshops/upcoming/graphramsey.

February 2015

* 2–6 **MBI Workshop on Tumor Heterogeneity and the Microenvironment**, Mathematical Biosciences Institute, The Ohio State University, Jennings Hall 3rd Floor, 1735 Neil Ave., Columbus, Ohio.
Description: Most solid tumors present as dense fibrotic masses, which suggests that fibroblasts contribute to tumor growth by infiltrating and depositing extracellular matrix proteins. Fibroblasts act in wound healing, angiogenesis and tissue remodeling by releasing growth factors and proteases such as matrix metalloproteinases. Therefore, if the growing tumor can co-opt such fibroblasts it has an unlimited source of many of the fundamental elements required for growth and invasion. The two central themes of this workshop are: - Heterogeneity (be it phenotypic, signaling or genotypic), and - Microenvironment (ECM, nutrients, fibroblasts and immune cells). Since a highly heterogeneous tumor has the potential to adapt to any microenvironment, understanding how interactions between the growing tumor and its microenvironment modulate tumor heterogeneity is critical to unraveling the mechanisms of cancer initiation.
Information: http://mbi.osu.edu/event/?id=819; phone: 614-292-3648.

2–March 8 **ICERM Semester Program: Phase Transitions and Emergent Properties**, Brown University, Providence, Rhode Island. (Mar. 2014, p. 317)

* 8–28 **Algebraic topology, geometric and combinatorial group theory**, Centro di Ricerca Matematica Ennio De Giorigi, Pisa, Italy.
Description: In Winter 2014-2015, a trimester on "Perspectives in Lie Theory" will be held at Centro de Giorgi. The third session of this trimester will be devoted to "Algebraic topology, geometric and combinatorial group theory". This session will include a seminar, time for discussions and collaboration, and three minicourses held by Vic Reiner (University of Minnesota), Ulrike Tillmann (University of Oxford), and Karen Vogtmann (University of Warwick).
Information: More information can be found at: http://www.crm.sns.it/event/293/activities.html#title; http://www.crm.sns.it/event/293/.

9–13 **Crystals, Quasicrystals and Random Networks**, Brown University, Providence, Rhode Island. (Mar. 2014, p. 317)

* 16–20 **MBI Workshop on Treatment, Clinical Trials and Resistance of Cancer**, Mathematical Biosciences Institute, The Ohio State University, Jennings Hall 3rd Floor, 1735 Neil Ave., Columbus, Ohio.
Description: This workshop will focus on two broad topics: Mathematical modeling of cancer treatment strategies and how to model resistance of cancers to drug treatments. Use of mathematical models to compare clinical trial arms and virtually simulate clinical trials outcomes. The workshop will highlight modeling applications that are as close as possible to direct clinical impact including design of multi-institutional clinical trials for patient-specific radiation dose strategies, quantification of patient-specific response to treatment that can be useful in predicting outcomes and treatment design, as well as include discussions of sequencing of drug treatments, optimal scheduling, and modeling of combination therapies which are useful in rapidly mutating diseases, such as cancer and HIV. The workshop will also discuss ways to implement the use of mathematical models in a clinical setting.
Information: http://mbi.osu.edu/event/?id=820; phone: 614-292-3648.

* 25–March 1 **Introductory Workshop**, Uppsala University, Uppsala, Sweden.
Description: Satellite of the Representation theory program at the Institute Mittag-Leffler.
Invited speakers: Alexander Alldridge (Cologne), Henning Haahr Andersen (Arhus), Karin Baur (Graz), Eleonore Faber (Toronto), Vyacheslav Futorny (Sao Paulo), Martin Herschend (Uppsala), Bernard Leclerc (Caen), Marco Mackaay (Algarve), Vanessa Miemietz (UEA), Idun Reiten (Trondheim), Claus Michael Ringel (Jeddah/Shanghai), Anne-Laure Thiel (Uppsala), Michela Varagnolo (Cergy-Pontoise), Eric Vasserot (Paris VII), Yu Zhou (Bielefeld).
Organizers: Aslak Bakke Buan and Volodymyr Mazorchuk.
Deadline: January 10, 2015.
Information: http://www.math.uu.se/IW2015/; email: iw2015@math.uu.se.

March 2015

* 14–18 **SIAM Conference on Computational Science and Engineering (CSE15)**, The Calvin L. Rampton Salt Palace Convention Center, Salt Lake City, Utah.
Description: The SIAM CS&E conference seeks to enable in-depth technical discussions on a wide variety of major computational efforts on large problems in science and engineering, foster the interdisciplinary culture required to meet these large-scale challenges, and promote the training of the next generation of computational scientists.
Information: http://www.siam.org/meetings/cse15/index.php.

16–20 **Small Clusters, Polymer Vesicles and Unusual Minima**, Brown University, Providence, Rhode Island. (Mar. 2014, p. 317)

* 23–27 **MBI Workshop on Targeting Cancer Cell Proliferation and Metabolism Networks**, Mathematical Biosciences Institute, The Ohio State University, Jennings Hall 3rd Floor, 1735 Neil Ave., Columbus, Ohio.
Description: This workshop will encompass a mix of experimentalists and mathematicians. Ideally, the former will be engaged on the production of large datasets on cancer cell proliferation, both at the cell population and single-cell level, and in response to microenvironment perturbations including anti-proliferative drugs. The latter will focus on mathematical models of proliferation and metabolism at several scales, including genetic, signaling and cellular, including a focus on the ability of cancer cell populations to regenerate and reprogram in response to hostile microenvironment and to targeted treatment, ultimately persisting in their proliferative state. Multi-scale models connecting the growth of cultured cancer cells and/or individual tumors to epidemiological data will also be considered. Although tumor growth and cancer cell proliferation have been modeled mathematically for decades, adequate datasets have been scarce and fragmentary due to experimental limitations.
Information: http://mbi.osu.edu/event/?id=821; phone: 614-292-3648.

* 27 **Philosophy of Information and Information Processing**, Pembroke College, Oxford, United Kingdom.
Description: The overall objective of this workshop is to study open questions within the philosophy of information and information processing, with an emphasis on the value of observed information and its measurement. Interest in the philosophy, meaning and value of information goes back half a century but has rapidly increased recently with many new directions of research into the meaning, quantification and measures of information and its complexity. Theoretic advances in these directions will have a huge impact on a wide range of real world applications.
Information: http://www.american.edu/cas/economics/info-metrics/workshop/workshop-2015-spring.cfm.

* 30–31 **3rd IMA International Conference on Flood Risk**, Swansea University, Wales, United Kingdom.
Description: Recent coastal and inland flooding events such as occurred in the UK, have highlighted the difficulties in forecasting individual and sequences of extreme events. The widespread and catastrophic flooding following the Japanese earthquake in March 2011 heightened the global public awareness of the limitations of existing flood defence infrastructure and flood warning systems. The conference will provide a forum at which engineers, mathematicians and statisticians can meet to exchange views on this important technical area. The emphasis will be on new developments in the mathematical and statistical techniques applicable for assessing flood risk. The conference will be of interest to flood defence practitioners; flood defence managers; statisticians, mathematicians and civil engineers.
Information: http://www.ima.org.uk/conferences/conferences_calendar.cfm.html.

April 2015

* 13–17 **Dynamics on Moduli Spaces**, Mathematical Sciences Research Institute, Berkeley, California.
Description: The Research Workshop of the "Dynamics on moduli spaces of geometric structures" will concentrate on some of the following general interrelated themes: (1) Geometric structures on the spaces of geometric structures which extend and generalize classical constructions on Teichmüller metric and its geodesic flow, Fenchel-Nielsen coordinates, Fock-Goncharov Thurson-Penner coordinates, and the symplectic and Poisson geometries (2) Relations with harmonic maps, Riemann surfaces, complex geometry: specifically Higgs bundles, holomorphic differentials (quadratic, cubic, etc.) as parameters for representations of the fundamental group, hyperkähler and complex symplectic geometry of moduli spaces, lifts of Teichmüller geodesic flows to flat bundles of character varieties (3) Asymptotic properties of higher Teichmüller spaces, including generalized measured geodesic laminations, Culler-Morgan-Shalen group.
Information: http://www.msri.org/workshops/743.

13–17 **Limit Shapes**, Brown University, Providence, Rhode Island. (Mar. 2014, p. 317)

* 13–17 **MBI Workshop on Stem Cells, Development, and Cancer**, Mathematical Biosciences Institute, The Ohio State University, Jennings Hall 3rd Floor, 1735 Neil Ave., Columbus, Ohio.
Description: What is the relationship between normal tissue stem cells and tumor-initiating cells (e.g., cancer stem cells)? Which signaling and other regulatory networks are altered in tumors relative to the normal tissues, and how do they function within the tumor? Finally, there is growing evidence that therapies aimed at the major cell types in tumors may sometimes make things worse, by leading

to an expansion in the fraction of cancer stem cells. How can this be avoided? This workshop will address these and other questions through discussions among mathematical and computational modelers and experimentalists. In particular, the strong connections between normal development, tumor growth and the use of novel treatment strategies will be discussed.
Information: http://mbi.osu.edu/event/?id=822; phone: 614-292-3648.

May 2015

* 6–10 **Representation Theory Workshop**, Uppsala University, Uppsala, Sweden.
Description: Satellite of the Representation Theory program at the Institute Mittag-Leffler.
Invited speakers: Aslak Bakke Buan (Trondheim), Vyjayanthi Chari (Riverside), Shun-Jen Cheng (Taipei), Kevin Coulembier (Ghent), Jonathan Kujawa (Oklahoma), Shrawan Kumar (Chapel Hill), Gus Lehrer (Sydney), George Lusztig (MIT), Steffen Oppermann (Trondheim), Ivan Penkov (Bremen), Loic Poulain d'Andecy (Amsterdam), Antonio Sartori (Bonn), Vera Serganova (Berkeley), Weiqiang Wang (Virginia), Kaiming Zhao (Waterloo).
Organizers: Henning Haahr Andersen and Volodymyr Mazorchuk.
Registration deadline: March 24, 2015.
Information: http://www.math.uu.se/rtw2015/; email: rtw2015@math.uu.se.

* 11–15 **Advances in Homogeneous Dynamics**, Mathematical Sciences Research Institute, Berkeley, California.
Description: The Advances in Homogeneous Dynamics workshop will feature the speakers whose work is at the forefront of the field. There will be a panel discussion accompanied by an open problem session to lay out possible directions for the research in homogeneous dynamics. Talks will be in a broad range of topics and this will help to build more connections between researchers interested in dynamical systems, number theory, and geometry. For example we hope that the involvement of the participants of the other program held at MSRI during the same academic year (Dynamics on Moduli Spaces of Geometric Structures, Spring 2015) would create new connections between the topics. There will be shorter talks presented by early-career researchers
Information: http://www.msri.org/workshops/738.

17–21 **SIAM Conference on Applications of Dynamical Systems (DS15)**, Snowbird Ski and Summer Resort, Snowbird, Utah. (May 2014, p. 556)

28–31 **3rd International Conference on "Applied Mathematics & Approximation Theory-AMAT 2015"**, Ankara, Turkey. (May 2014, p. 557)

The following new announcements will not be repeated until the criteria in the next to the last paragraph at the bottom of the first page of this section are met.

June 2015

* 15–19 **Connections in Discrete Mathematics**, Simon Fraser University, Vancouver, Canada.
Description: Discrete mathematics plays a central role in modern mathematics. This is in large part due to the work of Ron Graham. His work has spanned over five decades and includes over 300 published papers, 5 books, countless talks and editorial assignments, service as president of the AMS and the MAA, and the many connections that he has made in the mathematics community. His research encompasses number theory, graph theory, discrete geometry, Ramsey theory, combinatorics, algorithms, and more; often revealing surprising interconnections between these topics. To celebrate the life and work of Ron Graham, this conference will bring together prominent researchers in number theory, graph theory, combinatorics, probability, discrete geometry, and so on, to explore the connections between these areas of mathematics. In addition to plenary and invited talks we will have contributed talks. We particularly encourage graduate students and early career mathematicians to participate.
Information: http://sites.google.com/site/connectionsindiscretemath/.

* 22–24 **3rd International Conference on "Graph Modelling in Engineering"**, University of Bielsko-Biala, Bielsko-Biala, Poland.
Description: On behalf of Professor Józef Wojnarowski, the father of graph-based modelling of mechanical systems in Poland, we would like to invite you to participate in our conference. Upon the initiative of Professor Józef Wojnarowski, discussed among the members of Polish Committee on TMM, we would like to continue the tradition of two previous conferences which had been organized by the Silesian TU in Gliwice in 1993 and 1999.
Goal: Of our conference is to unite the society of scientists whose works are dedicated to an application of graphs into mechanical engineering and related fields of knowledge.
Scope: The scope is wide but narrower than other conferences on mathematical modeling or industrial mathematics. It is dedicated to an application not only graph theory but also discrete mathematics, combinatorics, number theory, network theory and some other related disciplines of mathematics. The tools, methods, algorithms and structures of these fields of mathematics could be utilized in versatile areas of mechanical engineering, mechanics, mechatronics and connected engineer and industry related areas. The full scope of the conference is given in the adequate subpage. In our opinion, the proposed scope gives a unique opportunity to join together all areas of graph-related applications which are usually considered separately as e.g., bond-graphs, Petri nets or graph grammars which, in fact, are closely and almost fully related to graph theory. Please, take into consideration that our proposal is rare on the market of contemporary conferences interwining all possible graph-related science and technical applications. We do hope that rebirthing of such a forum would be fruitful for all participants. Bielsko-Biala is an open, nice city with a multi-cultural, multi-nationality and multi-religious tradition which gives a friendly atmosphere for our meeting.
Information: email: szawislak@ath.bielsko.pl; email: gm2015@ath.eu.

July 2015

* 6–10 **Classical and quantum hyperbolic geometry and topology/Topologie et géométrie hyperbolique classique et quantique**, Université Paris-Sud, Orsay, France.
Description: This conference is in honnor of Francis Bonahon (University of Southern California); The main themes are low-dimensional topology, hyperbolic geometry, quantum Teichmüller theory, topological quantum field theory, higher Teichmüller theory.
Information: http://www.math.u-psud.fr/~paulin/Bonahon2015.html.

* 8–10 **SIAM Conference on Control and Its Applications (CT15)**, Maison de la Mutualit, Paris, France.
Description: The field of control theory is central to a wide range of aerospace, energy, automotive and advanced technological systems and is increasingly recognized as fundamental for emerging fields ranging from nanotechnology, smart grid to cell regulation. Moreover, in addition to its traditional ubiquity in process regulation for the physical sciences and engineering, control concepts now pervade the biological, computer, and social sciences. This conference will showcase a wide range of topics in control and systems theory. The topics and applications include control of PDEs, computational mathematics for control and optimization, real-time optimization and data assimilation, cooperative control for unmanned autonomous vehicles, differential games, cellular and biological regulation,

control of hybrid systems, control techniques for financial mathematics, biomedical control, risk sensitive control and filtering, control of smart systems, flow control and quantum control.
Information: http://www.siam.org/meetings/ct15/.

September 2015

* 9–December 4 **ICERM Semester Program: Computational Aspects of the Langlands Program**, Brown University, Providence, Rhode Island.
Description: During the semester we will focus on three specific aspects of the Langlands program. First, we will look at elliptic curves over number fields and genus 2 curves over the rationals and will consider their relationship to modular forms. Second, we will consider computational aspects of modular forms in higher rank. Specifically, we will examine K3 surfaces and their connections to modular forms on orthogonal groups. Our third topic concerns analytic aspects of L-functions, building upon and complementing the algebraic, arithmetic, and geometric data.
Information: http://icerm.brown.edu/sp-f15/.

December 2015

* 1–5 **BioInfoSummer 2014: Summer symposium in bioinformatics**, Monash University (Caufield Campus), Melbourne, Australia.
Description: Bioinformatics is an exciting, fast-moving area analysing and simulating the structures and processes of biological systems. BioInfoSummer introduces students, researchers and others working in related areas to the discipline. The program features: Introduction to biology and bioinformatics; evolutionary biology; systems biology; next generation sequencing; and coding and algorithms for bioinformatics.
Information: http://www.amsi.org.au/BIS.

January 2016

* 14–15 **Connections for Women: Differential Geometry**, Mathematical Sciences Research Institute, Berkeley, California.
Description: The purpose of this meeting is to help junior female researchers to become familiar with the focus topics of the main MSRI program, and also for the junior researchers to have an opportunity to get acquainted with more senior women researchers in differential geometry.
Information: http://www.msri.org/workshops/702.

* 18–22 **Introductory Workshop: Modern Riemannian Geometry**, Mathematical Sciences Research Institute, Berkeley, California.
Description: The week will be devoted to an introduction to modern techniques in Riemannian geometry. This is intended to help graduate students and younger researchers get a headstart, in order to increase their participation during the main semester programs and research lectures. To increase outreach, the week will focus on Riemannian geometry and should be largely accessible. Some minicourses on topics of recent interest will be included. The workshop will also have semi-expository lectures dealing with aspects of spaces with curvature bounded from below, since such spaces will occur throughout the semester. We expect that many Berkeley mathematicians and students will participate in the introductory workshop.
Information: http://www.msri.org/workshops/703.

March 2016

* 21–25 **Kähler Geometry, Einstein Metrics, and Generalizations**, Mathematical Sciences Research Institute, Berkeley, California.
Description: The workshop will integrate elements from complex differential geometry with Einstein metrics and their generalizations. The topics will include • Existence of Kähler-Einstein metrics and extremal Kähler metrics. Notions of stability in algebraic geometry such as Chow stability, K-stability, b-stability, and polytope stability. Kähler-Einstein metrics with conical singularities along a divisor. • Calabi-Yau metrics and collapsed limit spaces. Connections with physics and mirror symmetry. • Einstein metrics and their moduli spaces, ϵ-regularity, noncompact examples such as ALE, ALF, and Poincaré-Einstein metrics. Generalizations of the Einstein condition, such as Bach-flat metrics and Ricci solitons. • Sasaki-Einstein metrics and metrics with special holonomy. New examples and classification problems.
Information: http://www.msri.org/workshops/704.

May 2016

* 2–6 **Geometric Flows in Riemannian and Complex Geometry**, Mathematical Sciences Research Institute, Berkeley, California.
Description: The workshop will concentrate on parabolic methods in both Riemannian and complex geometry. The topics will include • Ricci flow. Analytic questions about Ricci flow in three dimensions. Possible applications of Ricci flow to 4-manifold topology. Ricci flow in higher dimensions under curvature assumptions. • Kähler-Ricci Flow. Applications to the Kähler-Einstein problem. Connections to the minimal model program. Study of Kähler-Ricci solitons and limits of Kähler-Ricci flow. • Mean curvature flow. Singularity analysis. Generic mean curvature flow. • Other geometric flows such as Calabi flow and pluriclosed flow.
Information: http://www.msri.org/workshops/705.

August 2016

* 28–30 **The 15th International Pure Mathematics Conference 2014 (15th IPMC 2014)**, Islamabad, Pakistan.
Description: The 15th International Pure Mathematics Conference 2014 (15th IPMC 2014) is the 15th international conference in the series of pure mathematics conferences that take place in Islaqmabad every year in August/September. It is a thematic conference which is held under the auspices of the Pakistan Mathematical Society, (http://www.pakms.org.pk) and Algebra Forum. (http://www.algebraforum.org.pk). It will provide a stimulating opportunity to meet experts from various countries in a variety of branches of pure mathematics.
Information: http://www.pmc.org.pk.

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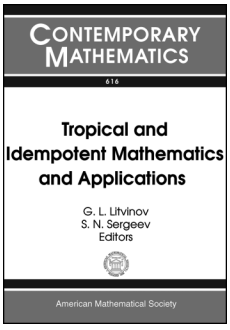
Algebra and Algebraic Geometry



Tropical and Idempotent Mathematics and Applications

G. L. Litvinov, *Independent University of Moscow, Russia*, and **S. N. Sergeev**, *University of Birmingham, United Kingdom*, Editors

This volume contains the proceedings of the International Workshop on Tropical and Idempotent Mathematics, held at the Independent University of Moscow, Russia, from August 26–31, 2012. The main purpose of the conference was to bring together and unite researchers and specialists in various areas of tropical and idempotent mathematics and applications.

This volume contains articles on algebraic foundations of tropical mathematics as well as articles on applications of tropical mathematics in various fields as diverse as economics, electroenergetic networks, chemical reactions, representation theory, and foundations of classical thermodynamics.

This volume is intended for graduate students and researchers interested in tropical and idempotent mathematics or in their applications in other areas of mathematics and in technical sciences.

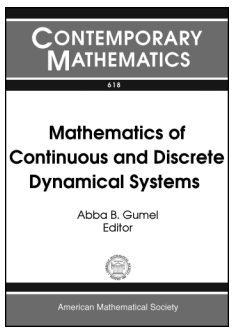
This item will also be of interest to those working in applications.

Contents: **M. Akian**, **S. Gaubert**, and **A. Guterman**, Tropical Cramer determinants revisited; **A. Avantaggiati** and **P. Loreti**, An approximation of Hopf-Lax type formula via idempotent analysis; **L. P. Belluce**, **A. Di Nola**, and **A. R. Ferraioli**, Ideals of MV-semirings and MV-algebras; **V. I. Danilov**, **A. V. Karzanov**, and **G. A. Koshevoy**, Tropical Plücker functions and Kashiwara crystals; **J Eskeldson**, **M. Jaffe**, and **V. Nitica**, A metric on max-min algebra; **M. Gavalec** and **K. Zimmermann**, Optimization on the range of a max-separable operator; **Z. Izhakian**, **M. Knebusch**, and **L. Rowen**, Algebraic structures of tropical mathematics; **B. Kh. Kirshtein**, Parametric dequantization, tropical reduction of hyperfields and steady states of AC electrical networks; **N. Krivulin**, A constrained tropical optimization problem: Complete solution and application example; **V. P. Maslov**, On the mathematical foundations of classical thermodynamics; **V. Matveenko**, Tropical support sets in analysis of weak links and complementarity; **D. Nikolayev**, Idempotent algebra models of single-agent and multi-agent dynamics; **V. Nitica** and **S. Sergeev**, Tropical convexity over max-min semiring; **V. Noel**, **D. Grigoriev**, **S. Vakulenko**, and **O. Radulescu**, Tropicalization and tropical equilibration of chemical reactions; **T. Nowak** and **B. Charron-Bost**, An overview of transience bounds in max-plus algebra; **E. Wagneur**, Strong independence and injectivity in tropical modules.

Contemporary Mathematics, Volume 616

May 2014, 300 pages, Softcover, ISBN: 978-0-8218-9496-5, LC 2013041902, 2010 *Mathematics Subject Classification:* 15A80, 16Y60, 05C20, 14T05, 52A30, 35F21, 90C48, 65H20, 92C42, 82B30, **AMS members US$81.60**, List US$102, Order code CONM/616

Differential Equations



Mathematics of Continuous and Discrete Dynamical Systems

Abba B. Gumel, *University of Manitoba, Winnipeg, Manitoba, Canada*, Editor

This volume contains the proceedings of the AMS Special Session on Nonstandard Finite-Difference Discretizations and Nonlinear Oscillations, in honor of Ronald Mickens's 70th birthday, held January 9–10, 2013, in San Diego, CA.

Included are papers on design and analysis of discrete-time and continuous-time dynamical systems arising in the natural and engineering sciences, in particular, the design of robust nonstandard finite-difference methods for solving continuous-time ordinary and partial differential equation models, the analytical and numerical study of models that undergo nonlinear oscillations, as well as the design of deterministic and stochastic models for epidemiological and ecological processes. Some of the specific topics covered in the book include the analysis of deterministic and stochastic SIR-type models, the assessment of cost-effectiveness of vaccination problems,

finite-difference methods for oscillatory dynamical systems (including the Schrödinger equation and Brusselator system), the design of exact and elementary stable finite-difference methods, the study of a two-patch model with Allee effects and disease-modified fitness, the study of the delay differential equation model with application to circadian rhythm and the application of some special functions in the solutions of some problems arising in the natural and engineering sciences.

A notable feature of the book is the collection of some relevant open problems, intended to help guide the direction of future research in the area.

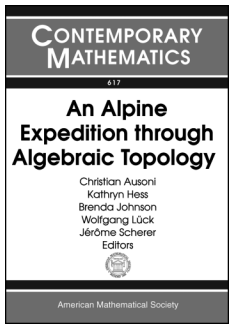
This item will also be of interest to those working in applications.

Contents: L. J. S. Allen and **E. J. Allen**, Deterministic and stochastic SIR epidemic models with power function transmission and recovery rates; **E. H. Elbasha** and **E. J. Dasbach**, Evaluating the cost-effectiveness of vaccination programs; **Y. Kang** and **C. Castillo-Chavez**, A simple two-patch epidemiological model with Allee effects and disease-modified fitness; **D. T. Dimitrov** and **H. V. Kojouharov**, Designing NSFD methods for models of population interactions; **J. M.-S. Lubuma**, **E. W. Mureithi**, and **Y. A. Terefe**, Nonstandard discretizations of the SIS epidemiological model with and without diffusion; **C. P. Vyasarayani** and **T. Kalmar-Nagy**, Galerkin-least squares approximations for delay differential equations: Application to a circadian rhythm model; **L.-I. W. Roeger**, Exact finite difference schemes; **A. Kroshko**, **O. Sharomi**, **A. B. Gumel**, and **R. J. Spiteri**, Design and analysis of NSFD methods for the diffusion-free Brusselator; **F. I. Moxley III**, **D. T. Chuss**, and **W. Dai**, An implicit generalized finite-difference time-domain scheme for solving nonlinear Schrödinger equations; **J. E. Macías-Díaz**, A dynamically consistent Mickens-type discretization of the Hodgkin-Huxley partial differential equation with non-polynomial reaction law; **M. Ehrhardt**, Nonstandard finite difference schemes for the Black–Scholes equation; **L. Cveticanin**, An analytical method for truly nonlinear oscillators; **P. M. Jordan**, A note on the Lambert W-function: Applications in the mathematical and physical sciences; **S. A. Rucker**, Leah-cosine and -sine functions: Definitions and elementary properties; **I. Kovacic**, On the use of special functions for studying truly nonlinear conservative oscillators; **R. E. Mickens**, I wish I knew how to...

Contemporary Mathematics, Volume 618

July 2014, 310 pages, Softcover, ISBN: 978-0-8218-9862-8, LC 2013044948, 2010 *Mathematics Subject Classification:* 34C15, 34D05, 34D20, 34D23, 37M20, 39A28, 39A30, 92B05, **AMS members US$91.20**, List US$114, Order code CONM/618

Geometry and Topology



An Alpine Expedition through Algebraic Topology

Christian Ausoni, *University of Paris XIII, Villetaneuse, France*, **Kathryn Hess**, *Ecole Polytechnique Federale de Lausanne, Switzerland*, **Brenda Johnson**, *Union College, Schenectady, NY*, **Wolfgang Lück**, *University of Bonn, Germany*, and **Jérôme Scherer**, *Ecole Polytechnique Federale de Lausanne, Switzerland*, Editors

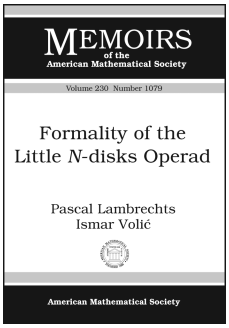
This volume contains the proceedings of the Fourth Arolla Conference on Algebraic Topology, which took place in Arolla, Switzerland, from August 20–25, 2012.

The papers in this volume cover topics such as category theory and homological algebra, functor homology, algebraic K-theory, cobordism categories, group theory, generalized cohomology theories and multiplicative structures, the theory of iterated loop spaces, Smith–Toda complexes, and topological modular forms.

Contents: A. Baker and **B. Richter**, Some properties of the Thom spectrum over loop suspension of complex projective space; **D. Barnes** and **C. Roitzheim**, Rational equivariant rigidity; **J. E. Bergner**, Homotopy colimits of model categories; **M. Bökstedt** and **I. Madsen**, The cobordism category and Waldhausen's K-theory; **R. R. Bruner**, Idempotents, localizations and Picard groups of $A(1)$-modules; **W. Chachólski**, Covers of groups; **E. Dotto**, A relative h-principle via cobordism-like categories; **R. Eldred**, Absolutely homotopy-cartesian squares; **B. Fresse**, Koszul duality complexes for the cohomology of iterated loop spaces of spheres; **B. Gray**, Periodicity, compositions and EHP sequences; **W. Lück** and **W. Steimle**, Non-connective K- and Nil-spectra of additive categories; **J. Noel**, $H_\infty \neq E_\infty$; **V. Stojanoska**, Calculating descent for 2-primary topological modular forms; **A. Touzé**, Applications of functor (co)homology; **L. Vokřínek**, Constructing homotopy equivalences of chain complexes of free $\mathbb{Z}G$-modules.

Contemporary Mathematics, Volume 617

July 2014, 296 pages, Softcover, ISBN: 978-0-8218-9145-2, LC 2013041956, 2010 *Mathematics Subject Classification:* 18A25, 18G10, 19Dxx, 19L41, 20D99, 55Nxx, 55Pxx, 55Uxx, 57R50, **AMS members US$81.60**, List US$102, Order code CONM/617



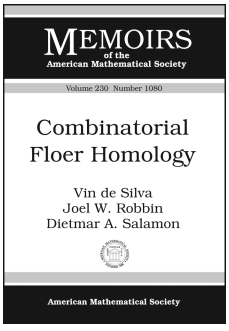
Formality of the Little N-disks Operad

Pascal Lambrechts, *Université Catholique de Louvain, Louvain-la-Neuve, Belgium*, and **Ismar Volić**, *Wellesley College, Massachusetts*

Contents: Introduction; Notation, linear orders, weak partitions, and operads; CDGA models for operads; Real homotopy theory of semi-algebraic sets; The Fulton-MacPherson operad; The CDGAs of admissible diagrams; Cooperad structure on the spaces of (admissible) diagrams; Equivalence of the cooperads $\mathcal{D}$ and $H^*(C[\bullet])$; The Kontsevich configuration space integrals; Proofs of the formality theorems; Index of notation; Bibliography.

Memoirs of the American Mathematical Society, Volume 230, Number 1079

June 2014, 116 pages, Softcover, ISBN: 978-0-8218-9212-1, LC 2014008206, 2010 *Mathematics Subject Classification:* 55P62; 18D50, **Individual member US$45**, List US$75, Institutional member US$60, Order code MEMO/230/1079



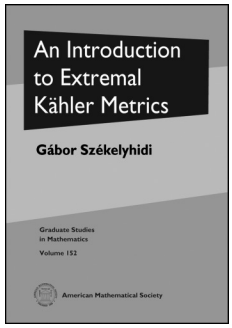
Combinatorial Floer Homology

Vin de Silva, *Pomona College, Claremont, CA*, **Joel W. Robbin**, *University of Wisconsin, Madison, WI*, and **Dietmar A. Salamon**, *ETH Zurich, Switzerland*

Contents: Introduction; *Part I. The Viterbo–Maslov Index:* Chains and traces; The Maslov index; The simply connected case; The Non simply connected case; *Part II. Combinatorial Lunes:* Lunes and traces; Arcs; Combinatorial lunes; *Part III. Floer Homology:* Combinatorial Floer homology; Hearts; Invariance under isotopy; Lunes and holomorphic strips; Further developments; *Appendices:* Appendix A. The space of paths; Appendix B. Diffeomorphisms of the half disc; Appendix C. Homological algebra; Appendix D. Asymptotic behavior of holomorphic strips; Bibliography; Index.

Memoirs of the American Mathematical Society, Volume 230, Number 1080

June 2014, 114 pages, Softcover, ISBN: 978-0-8218-9886-4, LC 2014008204, 2010 *Mathematics Subject Classification:* 57R58; 57R42, **Individual member US$45**, List US$75, Institutional member US$60, Order code MEMO/230/1080



An Introduction to Extremal Kähler Metrics

Gábor Székelyhidi, *University of Notre Dame, IN*

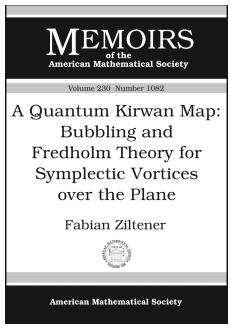
A basic problem in differential geometry is to find canonical metrics on manifolds. The best known example of this is the classical uniformization theorem for Riemann surfaces. Extremal metrics were introduced by Calabi as an attempt at finding a higher-dimensional generalization of this result, in the setting of Kähler geometry.

This book gives an introduction to the study of extremal Kähler metrics and in particular to the conjectural picture relating the existence of extremal metrics on projective manifolds to the stability of the underlying manifold in the sense of algebraic geometry. The book addresses some of the basic ideas on both the analytic and the algebraic sides of this picture. An overview is given of much of the necessary background material, such as basic Kähler geometry, moment maps, and geometric invariant theory. Beyond the basic definitions and properties of extremal metrics, several highlights of the theory are discussed at a level accessible to graduate students: Yau's theorem on the existence of Kähler-Einstein metrics, the Bergman kernel expansion due to Tian, Donaldson's lower bound for the Calabi energy, and Arezzo-Pacard's existence theorem for constant scalar curvature Kähler metrics on blow-ups.

Contents: Kähler geometry; Analytic preliminaries; Kähler-Einstein metrics; Extremal metrics; Moment maps and geometric invariant theory; K-stability; The Bergman kernel; CscK metrics on blow-ups; Bibliography; Index.

Graduate Studies in Mathematics, Volume 152

June 2014, 192 pages, Hardcover, ISBN: 978-1-4704-1047-6, LC 2014006619, 2010 *Mathematics Subject Classification:* 53C25, 53C55, 14L24, **AMS members US$45.60**, List US$57, Order code GSM/152



A Quantum Kirwan Map: Bubbling and Fredholm Theory for Symplectic Vortices over the Plane

Fabian Ziltener, *Korea Institute for Advanced Study, Seoul, Republic of Korea*

This item will also be of interest to those working in mathematical physics.

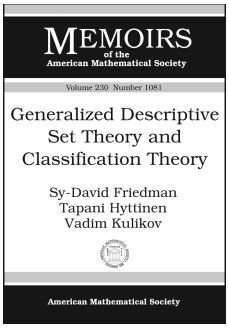
Contents: Motivation and main results; Bubbling for vortices over the plane; Fredholm theory for vortices over the plane; Appendix A. Auxiliary results about vortices, weighted spaces, and other topics; Bibliography.

Memoirs of the American Mathematical Society, Volume 230, Number 1082

June 2014, 129 pages, Softcover, ISBN: 978-0-8218-9472-9, LC 2014008203, 2010 *Mathematics Subject Classification:* 58D20, 53D45, **Individual member US$45.60**, List US$76, Institutional member US$60.80, Order code MEMO/230/1082

New AMS-Distributed Publications

Logic and Foundations



Generalized Descriptive Set Theory and Classification Theory

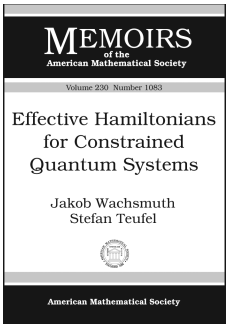
Sy-David Friedman, *Kurt Gödel Research Center, Vienna, Austria*, **Tapani Hyttinen**, *University of Helsinki, Finland*, and **Vadim Kulikov**, *Kurt Gödel Research Center, Vienna, Austria*

Contents: History and motivation; Introduction; Borel sets, Δ^1_1 sets and infinitary logic; Generalizations from classical descriptive set theory; Complexity of isomorphism relations; Reductions; Open questions; Bibliography.

Memoirs of the American Mathematical Society, Volume 230, Number 1081

June 2014, 80 pages, Softcover, ISBN: 978-0-8218-9475-0, LC 2014007649, 2010 *Mathematics Subject Classification:* 03C55, 03C45, 03E15, 03E47, 03C75, 03E35, **Individual member US$39**, List US$65, Institutional member US$52, Order code MEMO/230/1081

Mathematical Physics



Effective Hamiltonians for Constrained Quantum Systems

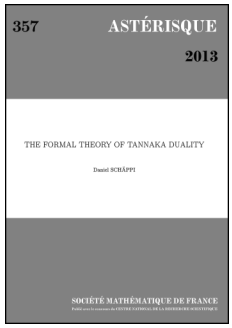
Jakob Wachsmuth, *University of Bremen, Germany*, and **Stefan Teufel**, *University of Tübingen, Germany*

Contents: Introduction; Main results; Proof of the main results; The whole story; Appendix A. Geometric definitions and conventions; Bibliography.

Memoirs of the American Mathematical Society, Volume 230, Number 1083

June 2014, 83 pages, Softcover, ISBN: 978-0-8218-9489-7, LC 2014008219, 2010 *Mathematics Subject Classification:* 81Q15; 35Q41, 58J37, 81Q70, **Individual member US$39**, List US$65, Institutional member US$52, Order code MEMO/230/1083

Algebra and Algebraic Geometry



The Formal Theory of Tannaka Duality

Daniel Schäppi, *University of Chicago, Illinois*

A Tannakian category is an abelian tensor category equipped with a fiber functor and additional structures which ensure that it is equivalent to the category of representations of some affine groupoid scheme acting on the spectrum of a field extension. If we are working over an arbitrary commutative ring rather than a field, the categories of representations cease to be abelian.

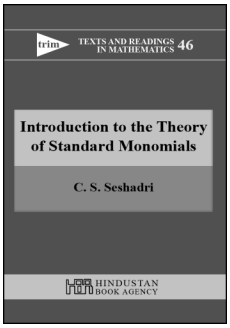
The author provides a list of sufficient conditions which ensure that an additive tensor category is equivalent to the category of representations of an affine groupoid scheme acting on an affine scheme, or, more generally, to the category of representations of a Hopf algebroid in a symmetric monoidal category. In order to do this he develops a "formal theory of Tannaka duality" inspired by Ross Street's "formal theory of monads." He applies his results to certain categories of filtered modules which are used to study p-adic Galois representations.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: Introduction; The category of filtered modules; Outline of the Tannakian biadjunction; The Tannakian biadjunction for general 2-categories; Details for the Tannakian biadjunction in **Mod**$(\mathcal{V})$; The recognition theorem in **Mod**$(\mathcal{V})$; Cosmoi with dense autonomous generator; Further simplifications when $\mathcal{V}$ is abelian; Tannakian duality for bialgebras and Hopf algebras; Affine groupoids over commutative rings; The Tannakian biadjunction for Gray monoids; Base change; Appendix A. Density in cosmoi with dense autonomous generator; Appendix B. Monoidal biadjunctions; Appendix C. A technical lemma; Appendix D. Tannaka duality for pseudomonoidal comonoids; Bibliography.

Astérisque, Number 357

December 2013, 140 pages, Softcover, ISBN: 978-2-85629-773-5, 2010 *Mathematics Subject Classification:* 14L15, 16T05, 18D20, **AMS members US$50.40**, List US$63, Order code AST/357



Introduction to the Theory of Standard Monomials

Second Edition

C. S. Seshadri, *Chennai Mathematical Institute, Tamil Nadu, India*

The aim of this book is to give an introduction to what has come to be known as Standard Monomial Theory (SMT). SMT deals with the construction of nice bases of finite dimensional irreducible representations of semi-simple algebraic groups or, in geometric terms, nice bases of coordinate rings of flag varieties (and their Schubert subvarieties) associated to these groups. Besides its intrinsic interest, SMT has applications to the study of the geometry of Schubert varieties. SMT has its origin in the work of Hodge, giving bases of the coordinate rings of the Grassmannian and its Schubert subvarieties by "standard monomials". In its modern form, SMT was developed by the author in a series of papers written in collaboration with V. Lakshmibai and C. Musili.

This book is a reproduction of a course of lectures given by the author in 1983–84 which appeared in the Brandeis Lecture Notes series. The aim of this course was to give an introduction to the series of papers by concentrating on the case of the full linear group. In recent years, there has been great progress in SMT due to the work of Peter Littelmann. Seshadri's course of lectures (reproduced in this book) remains an excellent introduction to SMT.

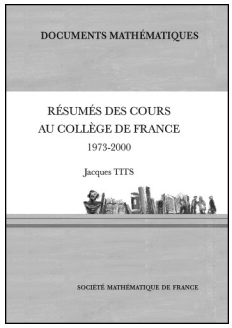
In this edition, Conjectures of a Standard Monomial Theory (SMT) for a general semi-simple (simply-connected) algebraic group, due to Lakshmibai, have been added as Appendix C. Many typographical errors have been corrected, and the bibliography has been revised.

A publication of Hindustan Book Agency; distributed within the Americas by the American Mathematical Society. Maximum discount of 20% for all commercial channels.

Contents: Introduction; Schubert varieties in the Grassmannian; Standard monomial theory on $\mathrm{SL}_n(k)/Q$; Applications; Schubert varieties in G/Q; Appendix A. Cohen-Macaulay Properties; Appendix B. Normality of Schubert varieties; Appendix C. Standard monomial theory; Bibliography; Notation; Index; Symbols.

Hindustan Book Agency

June 2014, 236 pages, Softcover, ISBN: 978-93-80250-42-7, **All Individuals US$38.40**, List US$48, Institutional member US$38.40, Order code HIN/34.R



Résumés des Cours au Collège de France

1973–2000

Jacques Tits, *Collège de France, Paris, France*

Jacques Tits held the chair of Group Theory at the Collège de France from 1973 to 2000. The present volume reproduces the summaries of his lectures, taken from the "Annuaires du Collège de France". The topics are either the work of other mathematicians, such as G. Margulis and R. Griess, or his own, e.g., on the theory of buildings; most of the results they contain have not been published elsewhere.

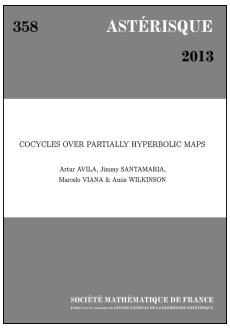
A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

For the table of contents, go to `www.ams.org/bookstore`.

Documents Mathématiques, Number 12

March 2014, 390 pages, Softcover, ISBN: 978-2-85629-774-2, 2010 *Mathematics Subject Classification:* 20Dxx, 20Fxx, 20Gxx, 51E24, **AMS members US$117.60**, List US$147, Order code SMFDM/12

Analysis



Cocycles Over Partially Hyperbolic Maps

Artur Avila, *CNRS UMR, Institut de Mathématiques de Jussieu, Paris, France*, **Jimmy Santamaria** and **Marcelo Viana**, *IMPA, Rio de Janeiro, Brazil*, and **Amie Wilkinson**, *University of Chicago, Illinois, USA*

The works collected in this volume, while addressing quite different goals, are focused on the same type of mathematical object: cocycles over partially hyperbolic diffeomorphisms.

The authors begin with a preliminary overview that provides background on the history and applications of the study of dynamical cocycles and partially hyperbolic theory and elucidates the connections between the two main articles. The first article investigates effective conditions which ensure that the Lyapunov spectrum of a (possibly non-linear) cocycle over a partially hyperbolic dynamical system is nontrivial. In the second article, the classical Livšic theory of the cohomological equation for Anosov diffeomorphisms is extended to accessible partially hyperbolic diffeomorphisms.

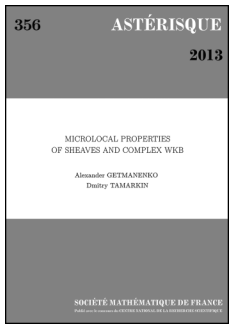
A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: **A. Avila**, **J. Santamaria**, **M. Viana**, and **A. Wilkinson**, Cocycles over partially hyperbolic maps; **A. Avila**, **J. Santamaria**, and **M. Viana**, Holonomy invariance: Rough regularity and applications to Lyapunov exponents; **A. Wilkinson**, The cohomological equation for partially hyperbolic diffeomorphisms; References.

Astérisque, Number 358

December 2013, 165 pages, Softcover, ISBN: 978-2-85629-778-0, 2010 *Mathematics Subject Classification:* 37A20, 37D25, 37D30, 37A50, 37C40, **AMS members US$57.60**, List US$72, Order code AST/358

Differential Equations



Microlocal Properties of Sheaves and Complex WKB

Alexander Getmanenko, *University of Tokyo, Japan*, and **Dmitry Tamarkin**, *Northwestern University, Evanston, Illinois, USA*

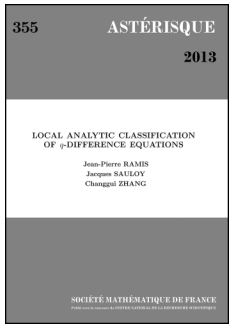
Kashiwara-Schapira style sheaf theory is used to justify analytic continuability of solutions of the Laplace transformed Schrödinger equation with a small parameter. This partially proves the description of the Stokes phenomenon for WKB asymptotics predicted by Voros in 1983.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: Introduction; Conventions and notations; Statement of the problem and main results; Orthogonality criterion—a simplified version; Orthogonality criterion for a generalized strip; Proof of Theorem 3.4; Identification of Φ^K and Ψ^K; Bibliography.

Astérisque, Number 356

December 2013, 151 pages, Softcover, ISBN: 978-2-85629-772-8, 2010 *Mathematics Subject Classification:* 35A27, **AMS members US$36.80**, List US$46, Order code AST/356



Local Analytic Classification of q-Difference Equations

Jean-Pierre Ramis and **Jacques Sauloy**, *Université Paul Sabatier, Toulouse, France*, and **Changgui Zhang**, *Université de Lille1, Villeneuve d'Ascq, France*

The authors essentially achieve Birkhoff's program for q-difference equations by giving three different descriptions of the moduli space of isoformal analytic classes. This involves an extension of Birkhoff-Guenther normal forms, q-analogues of the so-called Birkhoff-Malgrange-Sibuya theorems and a new theory of summation. The results were announced in *La variété des classes analytiques d'équations aux q-differences dans une classe formelle* and *Développement asymptotique et sommabilité des solutions des équations linéaires aux q-différences* and in various seminars and conferences between 2004 and 2006.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

About the cover, continued from page 610

inverse limit of circles, mapping onto each other by wrapping around roughly one and one-half times.

The controversy between Brouwer and Schoenflies, as well as subsequent history, is dealt with in §4.6 of the biography of Brouwer under review.

The color in Brouwer's diagram gave rise to some technical difficulties and thus correspondence among him, Hilbert, and Korteweg. Because of the color, his diagrams could not be printed on the pages of the article itself, and had to be inserted. Brouwer made the original diagram by hand at a size of about 60 cm by 70 cm, and this had to be reduced in size for insertion. It seems, from the evidence of a letter from Brouwer to Hilbert, that the journal's first response was to ask Brouwer to redraw his figures at a smaller scale. Brouwer objected strongly to this, insisting that it be only a last resort. He pointed out that in Amsterdam the printers could reduce and reproduce the diagrams by a photographic process, and asked with some asperity why German printers couldn't do the same. He even offered to pay for this himself. We do not know who did eventually pay.

Incidentally, the process he referred to was heliotypy, about which the Internet tells us much. It is a variation of the better known collotype process, and was extensively used for fast, inexpensive, high-quality reproduction of photographs. We are not sure how the printers handled the two colors.

We wish to thank Dirk van Dalen, the author of the biography under review, for supplying us with information about the publication of the diagram, and particularly for translating into English a letter, originally in Dutch, from Brouwer to Korteweg. He tells us that most of Brouwer's personal archives were unfortunately destroyed in a fire, so that what is extant concerning the production of the diagrams is sadly incomplete.

Also sadly, in the course of time many libraries have lost the colored inserts of Brouwer's article. It is slightly depressing to see that copies of this volume of the *Annalen* scanned for Internet archives do not include the inserts, either. (But then this is often true of inserted figures in old science books.) The photograph on the cover was made from the copy of the *Annalen* at the Institute for Advanced Study in Princeton, to which we are grateful.

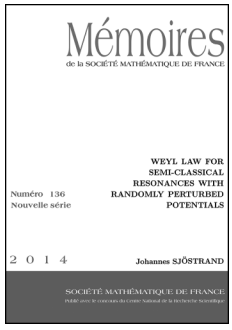
—Bill Casselman
Graphics Editor
(notices-covers@ams.org)

Contents: Introduction; Some general nonsense; The affine space of isoformal analytic classes; The q-analogs of Birkhoff-Malgrange-Sibuya theorems; Summation and asymptotic theory; Geometry of the space of classes; Examples of the Stokes phenomenon; Appendix. Classification of isograded filtered difference modules; Bibliography; Index of notations; Index.

Astérisque, Number 355

December 2013, 151 pages, Softcover, ISBN: 978-2-85629-775-9, 2010 *Mathematics Subject Classification:* 39A13; 34M50, **AMS members US$50.40**, List US$63, Order code AST/355

Mathematical Physics



Weyl Law for Semi-Classical Resonances with Randomly Perturbed Potentials

Johannes Sjöstrand, *Université de Bourgogne, Dijon, France*

The author considers semi-classical Schrödinger operators with potentials supported in a bounded strictly convex subset $\mathcal{O}$ of $\mathbb{R}^n$ with smooth boundary. Letting h denote the semi-classical parameter, the author considers classes of small random perturbations and shows that with probability very close to 1, the number of resonances in rectangles $[a,b]-i[0,ch^{\frac{2}{3}}]$ is equal to the number of eigenvalues in $[a,b]$ of the Dirichlet realization of the unperturbed operator in $\mathcal{O}$ up to a small remainder.

This item will also be of interest to those working in differential equations.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: Introduction; The result; Some elements of the proof; Grushin problems and determinants; Complex dilations; Semi-classical Sobolev spaces; Reductions to $\mathcal{O}$ and to $\partial\mathcal{O}$; Some ODE preparations; Parametrix for the exterior Dirichlet problem; Exterior Poisson operator and DN map; The interior DN map; Some determinants; Upper bounds on the basic determinant; Some estimates for P_{out}; Perturbation matrices and their singular values; End of the construction; End of the proof of Theorem 2.2 and proof of Proposition 2.4; Appendix. WKB estimates on an interval; Bibliography.

Mémoires de la Société Mathématique de France, Number 136

January 2014, 144 pages, Softcover, ISBN: 978-2-85629-780-3, 2010 *Mathematics Subject Classification:* 81U99, 35P20, 35P25, **AMS members US$41.60**, List US$52, Order code SMFMEM/136

Classified Advertisements

Positions available, items for sale, services available, and more

COMMENTS SOLICITED

A Solution to the 3x + 1 Problem?

In the Feb. issue of the *Notices*, we announced a possible solution to this very difficult problem. Although the number of daily visits to the on-line version of the paper doubled, we received no communications claiming errors in our solution. However, before we submit the paper for publication, we would like to have the paper read by as many qualified readers as possible, hence this ad. The first mathematicians who write us stating their belief that our solution is correct, will be mentioned in the Acknowledgments section of the published paper (but only with each mathematician's prior written approval). The paper is "A Solution to the 3x + 1 Problem" on http://occampress.com.

—Peter Schorer
peteschorer@gmail.com.
000022

CHILE

PONTIFICIA UNIVERSIDAD CATOLICA DE CHILE
Departments of Mathematics and Statistics

The Departments of Mathematics and Statistics of the Pontificia Universidad Catolica de Chile invite applications for two postdoctoral positions, one in Mathematics and the other in Statistics, starting at any date between May 2015 and September 2015. These positions are intended for a new or recent Ph.D. with outstanding potential in research. The duration of the position is one year, with the possibility of extension.

The approximate yearly salary will be of USD $32,000 plus USD $2,500 for moving expenses. Successful applicants will be required to apply to the Chilean national grant system.

Applications must include a cover letter, description of research plans, curriculum vitae, and three or more letters of recommendation. The application deadline date is December 12, 2014. Application materials should be sent to:

Alejandro Ramirez
Facultad de Matematicas
Pontificia Universidad
Catolica de Chile
Av. Vicua Mackenna 4860,
Macul, Santiago
fax: [56](2)25525916
email: aramirez@mat.puc.cl.
000023

BOOK FOR SALE

Book for sale on Amazon.com: D.S. Tselnik, Life of a Scientist.
000024

Suggested uses for classified advertising are positions available, books or lecture notes for sale, books being sought, exchange or rental of houses, and typing services.

The 2014 rate is $3.50 per word with a minimum two-line headline. No discounts for multiple ads or the same ad in consecutive issues. For an additional $10 charge, announcements can be placed anonymously. Correspondence will be forwarded.

Advertisements in the "Positions Available" classified section will be set with a minimum one-line headline, consisting of the institution name above body copy, unless additional headline copy is specified by the advertiser. Headlines will be centered in boldface at no extra charge. Ads will appear in the language in which they are submitted.

There are no member discounts for classified ads. Dictation over the telephone will not be accepted for classified ads.

Upcoming deadlines for classified advertising are as follows: August 2014 issue–May 29, 2014; September 2014 issue–June 30, 2014; October 2014 issue–July 29, 2014; November 2014 issue–September 4, 2014; December 2014 issue–September 30, 2014; January 2015–October 29, 2014.

U.S. laws prohibit discrimination in employment on the basis of color, age, sex, race, religion, or national origin. "Positions Available" advertisements from institutions outside the U.S. cannot be published unless they are accompanied by a statement that the institution does not discriminate on these grounds whether or not it is subject to U.S. laws. Details and specific wording may be found on page 1373 (vol. 44).

Situations wanted advertisements from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-321-4AMS (321-4267) in the U.S. and Canada or 401-455-4084 worldwide for further information.

Submission: Promotions Department, AMS, P.O. Box 6248, Providence, Rhode Island 02940; or via fax: 401-331-3842; or send email to classads@ams.org. AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 20904. Advertisers will be billed upon publication.

Meetings & Conferences of the AMS

IMPORTANT INFORMATION REGARDING MEETINGS PROGRAMS: AMS Sectional Meeting programs do not appear in the print version of the *Notices.* However, comprehensive and continually updated meeting and program information with links to the abstract for each talk can be found on the AMS website. See `http://www.ams.org/meetings/`. Final programs for Sectional Meetings will be archived on the AMS website accessible from the stated URL and in an electronic issue of the *Notices* as noted below for each meeting.

Tel Aviv, Israel

Bar-Ilan University, Ramat-Gan and Tel-Aviv University, Ramat-Aviv

June 16–19, 2014

Monday – Thursday

Meeting #1101

The Second Joint International Meeting between the AMS and the Israel Mathematical Union.
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: January 2014
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: Not applicable

Deadlines

For organizers: To be announced
For abstracts: To be announced

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/internmtgs.html`.

Invited Addresses

Ian Agol, University of California, Berkeley, *3-manifolds and cube complexes*.

Gil Kalai, Hebrew University, *Influence, thresholds, and noise sensitivity*.

Michael Larsen, Indiana University, *Borel's theorem on word maps and some recent variants*.

Andrei Okounkov, Columbia University, *The M-theory index*.

Leonid Polterovich, Tel-Aviv University, *Symplectic topology: From dynamics to quantization*.

Tamar Zeigler, Technion, Israel Institute of Technology, *Patterns in primes and dynamics on nilmanifolds*.

Special Sessions

Additive Number Theory, **Melvyn B. Nathanson**, City University of New York, and **Yonutz V. Stanchescu**, Afeka Tel Aviv Academic College of Engineering.

Algebraic Groups, Division Algebras and Galois Cohomology, **Andrei Rapinchuk**, University of Virginia, and **Louis H. Rowen** and **Uzi Vishne**, Bar Ilan University.

Applications of Algebra to Cryptography, **David Garber**, Holon Institute of Technology, and **Delaram Kahrobaei**, City University of New York Graduate Center.

Asymptotic Geometric Analysis, **Shiri Artstein** and **Boaz Klar'tag**, Tel Aviv University, and **Sasha Sodin**, Princeton University.

Combinatorial Games, **Aviezri Fraenkel**, Weizmann University, **Richard Nowakowski**, Dalhousie University, Canada, **Thane Plambeck**, Counterwave Inc., and **Aaron Siegel**, Twitter.

Combinatorics, **Gil Kalai**, Hebrew University of Jerusalem.

Dynamics and Number Theory, **Alex Kontorovich**, Yale University.

Field Arithmetic, **David Harbater**, University of Pennsylvania, and **Moshe Jarden**, Tel Aviv University.

Financial Mathematics, **Jean-Pierre Fouque**, University of California, and **Eli Merzbach** and **Malka Schaps**, Bar Ilan University.

Geometric Group Theory and Low-Dimensional Topology, **Ian Agol**, University of California, Berkeley, and **Zlil Sela**, Hebrew University.

Geometry and Dynamics, **Yaron Ostrover**, Tel Aviv University.

History of Mathematics, **Leo Corry**, Tel Aviv University, **Michael N. Fried**, Ben Gurion University, and **Victor Katz**, University of the District of Columbia.

Mirror Symmetry and Representation Theory, **Roman Bezrukavnikov**, Massachusetts Institute of Technology, and **David Kazhdan**, Hebrew University.

Nonlinear Analysis and Optimization, **Boris Mordukhovich**, Wayne State University, and **Simeon Reich** and **Alexander Zaslavski**, Technion Israel Institute of Technology.

PDEs: Modeling Theory and Numerics, **Edriss S. Titi**, University of California, Irvine.

Qualitative and Analytic Theory of ODE's, **Andrei Gabrielov**, Purdue University, and **Yossef Yomdin**, Weizmann Institute of Science.

Quasigroups, Loops and Applications, **Tuval Foguel**, Western Carolina University.

Random Matrix Theory, **Brendan Farrell**, California Institute of Technology, **Mark Rudelson**, University of Michigan, and **Ofer Zeitouni**, Weizmann Institute of Science.

Recent Trends in History and Philosophy of Mathematics, **Misha Katz**, Bar Ilan University, and **David Sherry**, Northern Arizona University.

Teaching with Mathematical Habits in Mind, **Theodore Eisenberg**, Ben Gurion University, **Davida Fishman**, California State University, San Bernardino, and **Jennifer Lewis**, Wayne State University.

The Mathematics of Menahem M. Schiffer, **Peter L. Duren**, University of Michigan, and **Lawrence Zalcman**, Bar Ilan University.

Topological Graph Theory and Map Symmetries, **Jonathan Gross**, Columbia University, and **Toufik Mansour**, University of Haifa.

Eau Claire, Wisconsin

University of Wisconsin-Eau Claire

September 20–21, 2014

Saturday – Sunday

Meeting #1102

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: June 2014
Program first available on AMS website: August 7, 2014
Program issue of electronic *Notices*: September 2014
Issue of *Abstracts*: Volume 35, Issue 3

Deadlines

For organizers: Expired
For abstracts: Expired

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Matthew Kahle, Ohio State University, *To be announced.*

Markus Keel, University of Minnesota, *To be announced.*

Svitlana Mayboroda, University of Minnesota, *To be announced.*

Dylan Thurston, Indiana University, *To be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at `http://www.ams.org/cgi-bin/abstracts/abstract.pl`.

Algebraic Combinatorics, **Pavlo Pylyavskyy**, **Victor Reiner**, and **Dennis Stanton**, University of Minnesota.

Algorithms in Algebraic Geometry, **Adriana Salerno**, Bates College, and **Ursula Whitcher**, University of Wisconsin-Eau Claire.

Analysis and Geometry on Lie Groups, **Chal Benson** and **Gail Ratcliff**, East Carolina University.

Cohomology and Representation Theory of Groups and Related Structures, **Christopher Bendel**, University of Wisconsin-Stout, and **Christopher Drupieski**, De Paul University.

Commutative Ring Theory, **Michael Axtell**, University of St. Thomas, and **Joe Stickles**, Millikin University.

Directions in Commutative Algebra: Past, Present and Future, **Joseph P. Brennan**, University of Central Florida, and **Robert M. Fossum**, University of Illinois at Urbana-Champaign.

Graph and Hypergraph Theory, **Sergei Bezrukov**, University of Wisconsin-Superior, **Dalibor Froncek**, University of Minnesota Duluth, and **Xiaofeng Gu**, **Uwe Leck**, and **Steven Rosenberg**, University of Wisconsin-Superior.

Knot Concordance and 4-Manifolds, **Christopher W. Davis**, University of Wisconsin-Eau Claire, **Taylor Martin**, Sam Houston State University, and **Carolyn Otto**, University of Wisconsin-Eau Claire.

Lie Algebras and Representation Theory, **Michael Lau**, Université Laval, **Ian Musson**, University of Wisconsin-Milwaukee, and **Matthew Ondrus**, Weber State University.

New Trends in Toric Varieties, **Christine Berkesch Zamaere**, University of Minnesota, **Daniel Erman**, University of Wisconsin-Madison, and **Hal Schenck**, University of Illinois Urbana-Champaign.

Number Theory, **Colleen Duffy**, University of Wisconsin-Eau Claire, and **Rafe Jones**, Carleton College.

Patterns in Permutations and Words, and Applications, **Manda Riehl**, University of Wisconsin-Eau Claire, and **Alex Woo**, University of Idaho.

Problem Solving in Extremal Combinatorics and Combinatorial Geometry, **Jeremy Alm**, Illinois College, and **Jacob Manske**, Epic.

Random Spaces, **Matthew Kahle**, Ohio State University, and **Dylan Thurston**, Indiana University.

The Mathematical Education of Future K-12 Teachers, **Charles Bingen** and **Ryan Harrison**, University of Wisconsin-Eau Claire.

Wavelets, Frames, and Time-Frequency Analysis, **Patrick Van Fleet**, University of St. Thomas, and **James S. Walker**, University of Wisconsin-Eau Claire.

von Neumann Algebras and Related Fields, **Stephen Avsec** and **Ken Dykema**, Texas A&M University.

Halifax, Canada

Dalhousie University

October 18–19, 2014

Saturday – Sunday

Meeting #1103

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: August 2014
Program first available on AMS website: September 5, 2014
Program issue of electronic *Notices*: October 2014
Issue of *Abstracts*: Volume 35, Issue 3

Deadlines

For organizers: Expired
For abstracts: August 19, 2014

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

François Bergeron, Université du Québec à Montréal, *Algebraic combinatorics and finite reflection groups*.

Sourav Chatterjee, Stanford University, *Nonlinear large deviations*.

William M. Goldman, University of Maryland, *Moduli spaces and the classification of geometric structures on manifolds*.

Sujatha Ramdorai, University of British Columbia, *Galois representations and Iwasawa theory*.

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at `http://www.ams.org/cgi-bin/abstracts/abstract.pl`.

Advances in Harmonic Analysis and Partial Differential Equations (Code: SS 14A), **David Cruz-Uribe**, Trinity College, and **Scott Rodney**, Cape Breton University.

Combinatorial Representation Theory (Code: SS 8A), **Cristina Ballantine**, College of the Holy Cross, **Rosa Orellana**, Dartmouth College, and **Mercedes Rosas**, Universidad de Sevilla.

Commutative Algebra and Its Interactions with Algebraic Geometry (Code: SS 2A), **Susan Marie Cooper**, Central Michigan University, **Sara Faridi**, Dalhousie University, and **William Traves**, U.S. Naval Academy.

Differential Geometry and Mathematical Physics (Code: SS 7A), **Virginie Charette**, Université de Sherbrooke, and **Karin Melnick**, University of Maryland.

Experimental Mathematics in Number Theory, Analysis, and Combinatorics (Code: SS 10A), **Marc Chamberland**, Grinnell College, and **Karl Dilcher**, Dalhousie University.

Games on Graphs (Code: SS 6A), **Jason Brown** and **Janette Janssen**, Dalhousie University.

General Relativity (Code: SS 12A), **Jack Gegenberg**, University of New Brunswick.

Generalized Catalan Algebraic Combinatorics (Code: SS 9A), **François Bergeron** and **Franco Saliola**, Université du Québec á Montréal, **Hugh Thomas**, University of New Brunswick, and **Nathan Williams**, Université du Québec á Montréal.

Hopf Algebras (Code: SS 11A), **Margaret Beattie**, Mount Allison University, and **Mitja Mastnak**, Saint Mary's University.

New Directions in Category Theory (Code: SS 5A), **Pieter Hofstra**, University of Ottawa, and **Dorette Pronk**, Dalhousie University.

p-adic Methods in Arithmetic (Code: SS 1A), **Henri Darmon**, McGill University, **Adrian Iovita**, Concordia University, and **Sujatha Ramdorai**, University of British Columbia.

Sampling Theory (Code: SS 4A), **John J. Benedetto**, University of Maryland, **Jean-Pierre Gabardo**, McMaster University, and **Ozgur Yilmaz**, University of British Columbia.

Special Functions and Their Applications. (Code: SS 3A), **Mourad E. H. Ismail**, University of Central Florida, and **Nasser Saad**, University of Prince Edward Island.

Symbolic Dynamics and Combinatorics on Words (Code: SS 13A), **Srecko Brlek**, Université du Québec á Montréal, and **Reem Yassawi**, Trent University.

San Francisco, California

San Francisco State University

October 25–26, 2014

Saturday – Sunday

Meeting #1104

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: August 2014
Program first available on AMS website: September 11, 2014
Program issue of electronic *Notices*: October 2014
Issue of *Abstracts*: Volume 35, Issue 4

Deadlines

For organizers: Expired
For abstracts: September 3, 2014

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Kai Behrend, University of British Columbia, Vancouver, Canada, *Title to be announced*.

Kiran S. Kedlaya, University of California, San Diego, *Title to be announced*.

Julia Pevtsova, University of Washington, Seattle, *Title to be announced.*

Burt Totaro, University of California, Los Angeles, *Title to be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at http://www.ams.org/cgi-bin/abstracts/abstract.pl.

Algebraic Geometry (Code: SS 1A), **Renzo Cavalieri**, Colorado State University, **Noah Giansiracusa**, University of California, Berkeley, and **Burt Totaro**, University of California, Los Angeles.

Algebraic Statistics (Code: SS 8A), **Elizabeth Gross**, San Jose State University, and **Kaie Kubjas**, Aalto University.

Applications of Knot Theory to the Entanglement of Biopolymers (Code: SS 15A), **Javier Arsuaga**, San Francisco State University, **Michael Szafron**, University of Saskatchewan, and **Mariel Vazquez**, San Francisco State University.

Categorical Methods in Representation Theory (Code: SS 4A), **Eric Friedlander**, University of Southern California, **Srikanth Iyengar**, University of Nebraska, Lincoln, and **Julia Pevtsova**, University of Washington.

Combinatorics and Algebraic Geometry (Code: SS 9A), **Madhusudan Manjunath**, University of California, Berkeley, and **Farbod Shokrieh**, Cornell University.

Geometry of Submanifolds (Code: SS 3A), **Yun Myung Oh**, Andrews University, **Bogdan D. Suceava**, California State University, Fullerton, and **Mihaela B. Vajiac**, Chapman University.

Hamiltonian Partial Differential Equations (Code: SS 12A), **Marius Beceanu**, University of California, Berkeley, **Magdalena Czubak**, Binghamton University, **Dong Li**, University of British Columbia, and **Xiaoyi Zhang**, University of Iowa.

High -Dimensional Convexity and Applications (Code: SS 14A), **Luis Rademacher**, Ohio State University, **Stanislaw Szarek**, Case Western Reserve University and Université Pierre et Marie Curie-Paris 6, and **Elisabeth Werner**, Case Western Reserve University, Université de Lille 1, UFR de Mathématique.

Homotopy Theory (Code: SS 11A), **Julie Bergner**, University of California, Riverside, and **Angélica Osorno**, Reed College.

Interactions between Knots and Manifolds (Code: SS 10A), **Stanislav Jabuka**, University of Nevada, Reno, **Swatee Naik**, University of Nevada, Reno, and **Cornelia Van Cott**, University of San Francisco.

Nonlinear Partial Differential Equations (Code: SS 6A), **Nathan Glatt-Holtz**, Virginia Tech, **Geordie Richards**, University of Rochester, and **Vlad Vicol**, Princeton University.

Polyhedral Number Theory (Code: SS 2A), **Matthias Beck**, San Francisco State University, **Martin Henk**, Universität Magdeburg, and **Joseph Gubeladze**, San Francisco State University.

Probabilistic and Statistical Problems in Stochastic Dynamics (Code: SS 7A), **Alexandra Piryatinska**, San Francisco State University.

Recent Progress in Geometric Analysis (Code: SS 5A), **David Bao**, San Francisco State University, and **Ovidiu Munteanu**, University of Connecticut.

Recent Progress in Harmonic Analysis and Several Complex Variables (Code: SS 16A), **Gustavo Hoepfner** and **Paulo Liboni**, Universidade Federal de São Carlos, and **Irina Mitrea**, Temple University.

Topological Combinatorics and Combinatorial Commutative Algebra (Code: SS 13A), **Anton Dochtermann**, University of Miami, **Augustine O'Keefe**, University of Kentucky, and **Alexander Engstrom**, Aalto University.

Greensboro, North Carolina

University of North Carolina at Greensboro

November 8–9, 2014

Saturday – Sunday

Meeting #1105

Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: August 2014
Program first available on AMS website: September 25, 2014
Program issue of electronic *Notices*: November 2014
Issue of *Abstracts*: Volume 35, Issue 4

Deadlines

For organizers: Expired
For abstracts: September 23, 2014

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Susanne C. Brenner, Louisiana State University, *Title to be announced.*

Skip Garibaldi, Emory University, *Title to be announced.*

Stavros Garoufalidis, Georgia Institute of Technology, *Knots and q-series.*

James Sneyd, University of Auckland, *Title to be announced* (AMS-NZMS Maclaurin Lecture).

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at http://www.ams.org/cgi-bin/abstracts/abstract.pl.

Algebraic Structures Motivated by Knot Theory (Code: SS 9A), **Jozef H. Przytycki**, George Washington University, and **Radmila Sazdanovic**, North Carolina State University.

Algorithms for Local Fields (Code: SS 14A), **Chad Awtrey**, Elon University, and **Sebastian Pauli**, University of North Carolina at Greensboro.

Automorphic Forms and Related Topics (Code: SS 11A), **Matthew Boylan**, University of South Carolina, **Jayce Getz**, Duke University, and **Dan Yasaki**, University of North Carolina at Greensboro.

Connections in Number Theory (Code: SS 20A), **Joseph Vandehey**, University of Georgia.

Difference Equations and Applications (Code: SS 1A), **Michael A. Radin**, Rochester Institute of Technology, and **Youssef Raffoul**, University of Dayton.

Discontinuous Galerkin Finite Element Methods (Code: SS 13A), **Susanne C. Brenner** and **Joscha Gedicke**, Louisiana State University, and **Thomas Lewis**, University of North Carolina at Greensboro.

Discrete Structures in Classical Geometries (Code: SS 4A), **Philip L. Bowers**, Florida State University.

Exceptional Groups in Physics, Algebra, and Geometry (Code: SS 17A), **Asher Auel**, Yale University, **Anthony Ruozzi**, Emory University, and **George McNinch**, Tufts University.

Galois Theory and Its Interactions with Algebra and Number Theory (Code: SS 12A), **Chad Awtrey**, Elon University, and **Michael Bush**, Washington and Lee University.

Geometric Analysis (Code: SS 6A), **Hubert Bray**, Duke University, and **Andrew Cooper**, North Carolina State University.

Geometry and Combinatorics on Homogeneous Spaces (Code: SS 10A), **Leonardo C. Mihalcea**, Virginia Tech University, and **Richard Rimanyi**, University of North Carolina Chapel Hill.

Knot Theory and Its Applications (Code: SS 7A), **Elizabeth Denne**, Washington & Lee University, and **Laura Taalman**, James Madison University.

Mirror Symmetry (Code: SS 18A), **Matthew Ballard**, University of South Carolina, and **David Favero**, University of Alberta.

Movement in Mathematical Biology (Code: SS 19A), **Jonathan T. Rowell** and **Jan Rychtar**, University of North Carolina at Greensboro.

Multiple Combinatorial Numbers and Associated Identities (Code: SS 16A), **Hasan Coskun**, Texas A&M University Commerce.

Nonlinear Boundary Value Problems (Code: SS 5A), **Maya Chhetri**, University of North Carolina at Greensboro, and **Stephen Robinson**, Wake Forest University.

Partial Differential Equations Related to Fluids (Code: SS 15A), **Dhanapati Adhikari**, Marywood University.

Recent Advances in Numerical Methods for Fluid Flow Problems (Code: SS 2A), **Leo Rebholz**, Clemson University, and **Zhu Wang**, University of South Carolina.

Recent Developments in Graph Theory and Hypergraph Theory (Code: SS 3A), **David Galvin**, University of Notre Dame, and **Clifford Smyth**, University of North Carolina at Greensboro.

Set Theoretic Topology (Code: SS 8A), **Peter J. Nyikos**, University of South Carolina, and **Jerry Vaughan**, University of North Carolina at Greensboro.

San Antonio, Texas

Henry B. Gonzalez Convention Center and Grand Hyatt San Antonio

January 10–13, 2015

Saturday – Tuesday

Meeting #1106

Joint Mathematics Meetings, including the 121st Annual Meeting of the AMS, 98th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: October 2014
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2015
Issue of *Abstracts*: Volume 36, Issue 1

Deadlines

For organizers: Expired
For abstracts: September 16, 2014

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/national.html`.

Joint Invited Addresses

Donald G. Saari, University of California, Irvine, *Title to be announced* (MAA-AMS-SIAM Gerald and Judith Porter Public Lecture).

AMS Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at `http://jointmathematicsmeetings.org/meetings/abstracts/abstract.pl?type=jmm`.

Some sessions are cosponsored with other organizations. These are noted within the parenthesis at the end of each listing, where applicable.

Accelerated Advances in Multiobjective Optimal Control Problems and Mathematical Programming Based on Generalized Invexity Frameworks (Code: SS 4A), **N. J. Huang**, Sichuan University, **R. N. Mohapatra**, University of Central Florida, **Ram Verma**, Texas State University, and **Alexander Zaslavski**, Israel Institute of Technology.

Advances in Coding Theory (Code: SS 21A), **Felice Manganiello** and **Gretchen L. Matthews**, Clemson University, and **Judy L. Walker**, University of Nebraska.

Algebraic Combinatorics and Representation Theory (Code: SS 36A), **Zajj Daugherty**, Dartmouth College, and **Ben Salisbury**, Central Michigan University.

Applications of Dynamical Systems to Biological Models (Code: SS 18A), **Yu Jin**, University of Nebraska-Lincoln, and

Xiang-Sheng Wang, Southeast Missouri State University (AMS-AAAS).

Beyond First-Order Model Theory (Code: SS 55A), **John T. Baldwin**, University of Illinois at Chicago, **Xavier Caicedo**, Universidad de los Andes, **Rami Grossberg**, Carnegie Mellon University, **Jose Iovino**, University of Texas at San Antonio, and **Boris Zilber**, Oxford University (AMS-ASL).

Classification Problems in Operator Algebras (Code: SS 47A), **Arnaud Brothier**, Vanderbilt University, **Ionut Chifan**, The University of Iowa, **Darren Creutz**, Vanderbilt University, **Remus Nicoara**, University of Tennessee, and **David Penneys**, University of Toronto.

Computing Intensive Modeling in Mathematical and Computational Biology (Code: SS 29A), **Timothy D. Comar**, Benedictine University, **Olcay Akman**, Illinois State University, and **Daniel Hrozencik**, Chicago State University.

Continued Fractions (Code: SS 43A), **James Mc Laughlin**, West Chester University, and **Nancy J. Wyshinski**, Trinity College.

Creating Coherence in K–12 Mathematics (Code: SS 50A), **Brigitte Lahme**, Sonoma State University, **William McCallum** and **Cody Patterson**, University of Arizona, **Kristin Umland**, University of New Mexico, and **Ellen Whitesides**, University of Arizona.

Current Trends in Classical Dynamical Systems (Code: SS 25A), **Lennard Bakker** and **Skyler Simmons**, Brigham Young University (AMS-AAAS).

Difference Equations and Applications (Code: SS 3A), **Michael A. Radin**, Rochester Institute of Technology.

Differential Geometry and Statistics (Code: SS 45A), **Susan Holmes**, Stanford University.

Enumerative Combinatorics (Code: SS 30A), **Brian K. Miceli**, Trinity University, and **Jay Pantone** and **Vince Vatter**, University of Florida.

Ergodic Theory and Dynamical Systems (Code: SS 32A), **Mrinal Kanti Roychowdhury**, University of Texas-Pan American.

Factorization Theory and Its Applications (Code: SS 11A), **Nicholas Baeth**, University of Central Missouri, **Scott Chapman**, Sam Houston State University, **Jim Coykendall**, Clemson University, and **Alfred Geroldinger**, Karl Franzens University.

Fixed Point Theory and Applications (Code: SS 13A), **Clement Boateng Ampadu**, Northeastern University.

Fractional, Stochastic, and Hybrid Dynamic Systems with Applications (Code: SS 5A), **John R. Graef**, University of Tennessee at Chattanooga, **G. S. Ladde**, University of South Florida, and **A. S. Vatsala**, University of Louisiana at Lafayette.

Frames and Their Applications (Code: SS 33A), **Radu Balan** and **Kasso Okoudjou**, University of Maryland, and **Rachel Ward**, University of Texas.

Geometries Defined by Differential Forms (Code: SS 38A), **Sergey Grigorian**, University of Texas-Pan American, **Sema Salur**, University of Rochester, and **Albert J. Todd**, University of California, Riverside.

Geosystems Mathematics (Code: SS 54A), **Willi Freeden**, University of Kaiserslautern, **Volker Michel**, University of Siegen, and **M. Zuhair Nashed**, University of Central Florida.

Graphs, Matrices, and Related Problems (Code: SS 23A), **Cheryl Grood** and **Thomas Hunter**, Swarthmore College, and **Sharon McCathern**, Azusa Pacific University.

Groups, Algorithms, and Cryptography (Code: SS 2A), **Bren Cavallo**, City University of New York Graduate Center, and **Delaram Kahrobaei**, City University of New York Graduate Center.

Heavy-Tailed Distributions and Processes (Code: SS 52A), **U. Tuncay Alparslan** and **John P. Nolan**, American University.

History of Mathematics (Code: SS 24A), **Sloan Despeaux**, Western Carolina University, **Patti Hunter**, Westmont College, **Deborah Kent**, Drake University, and **Adrian Rice**, Randolph-Macon College (AMS-MAA).

Holomorphic Dynamics in One and Several Variables (Code: SS 51A), **Tanya Firsova**, State University of New York at Stony Brook and Kansas State University, and **Thomas Sharland**, State University of New York at Stony Brook.

Hopf Algebras and Tensor Categories (Code: SS 6A), **Susan Montgomery**, University of Southern California, **Siu-Hung Ng**, Louisiana State University and Iowa State University, and **Sarah Witherspoon**, Texas A&M University.

Inequalities and Quantitative Approximation (Code: SS 1A), **Feng Dai**, University of Alberta, and **Mourad E. H. Ismail**, University of Central Florida.

Inverse Problems (Code: SS 49A), **Peter Muller**, Rensselaer Polytechnic Institute, and **Kaitlyn Voccola**, Colorado State University.

Knot Theory (Code: SS 10A), **Tim Cochran** and **Shelly Harvey**, Rice University.

Limits of Discrete Structures (Code: SS 26A), **Peter Diao**, **Dominique Guillot**, **Apoorva Khare**, and **Bala Rajaratnam**, Stanford University.

MAA General Contributed Paper Session on Research in Applied Mathematics (Code: MCPGENVL), **Kristen Meyer**, Wisconsin Lutheran College, **Bem Cayco**, San Jose State University, and **Kimberly Presser**, Shippensburg University of Pennsylvania (AMS-MAA-MER).

MAA General Contributed Paper Session on Research in Graph Theory (Code: MCPGENVN), **Kristen Meyer**, Wisconsin Lutheran College, **Bem Cayco**, San Jose State University, and **Kimberly Presser**, Shippensburg University of Pennsylvania (AMS-MAA-MER).

MAA General Contributed Paper Session on Research in Linear Algebra (Code: MCPGENVO), **Kristen Meyer**, Wisconsin Lutheran College, **Bem Cayco**, San Jose State University, and **Kimberly Presser**, Shippensburg University of Pennsylvania (AMS-MAA-MER).

MAA General Contributed Paper Session on Research in Logic or Foundations (Code: MCPGENVP), **Kristen Meyer**, Wisconsin Lutheran College, **Bem Cayco**, San Jose State University, and **Kimberly Presser**, Shippensburg University of Pennsylvania (AMS-MAA-MER).

MAA General Contributed Paper Session on Research in Number Theory (Code: MCPGENVQ), **Kristen Meyer**, Wisconsin Lutheran College, **Bem Cayco**, San Jose State University, and **Kimberly Presser**, Shippensburg University of Pennsylvania (AMS-MAA-MER).

Math Teachers Circles and the K–20 Continuum (Code: SS 41A), **Brian Conrey**, American Institute of Mathematics, **Michael Nakamaye** and **Kristin Umland**, University of New Mexico, and **Diana White**, University of Colorado at Denver.

Mathematics in Natural Resource Modeling (Code: SS 44A), **Shandelle M. Henson**, Andrews University, and **Catherine A. Roberts**, College of the Holy Cross.

Mathematics in Poland: Interbellum, World War II, and Immediate Post-War Developments (Code: SS 42A), **Mohammad Javaheri** and **Emelie A. Kenney**, Siena College.

Model Theory and Applications (Code: SS 48A), **David Marker**, University of Illinois at Chicago, **Sergei Starchenko**, University of Notre Dame, and **Carol Wood**, Wesleyan University.

Noncommutative Function Theory (Code: SS 16A), **Paul S. Muhly**, University of Iowa, and **Gelu F. Popescu**, University of Texas at San Antonio.

Operator Algebras and Their Applications: A Tribute to Richard V. Kadison (Code: SS 40A), **Robert S. Doran** and **Efton Park**, Texas Christian University.

Partitions, q-Series, and Modular Forms (Code: SS 37A), **Atul Dixit**, Tulane University, **Tim Huber**, University of Texas-Pan American, and **Ae Ja Yee**, Pennsylvania State University.

Positivity and Matrix Inequalities (Code: SS 35A), **Dominique Guillot**, **Apoorva Khare**, and **Bala Rajaratnam**, Stanford University.

Probability and Applications (Code: SS 34A), **Rick Kenyon**, Brown University, and **Russell Lyons**, Indiana University.

Progress in Multivariable Operator Theory (Code: SS 20A), **Ron Douglas**, Texas A&M University, and **Constanze Liaw**, Baylor University (AMS-AAAS).

Quantum Markov Chains, Quantum Walks, and Related Topics (Code: SS 7A), **Chaobin Liu**, Bowie State University, **Takuya Machida**, University of California, Berkeley, **Salvador E. Venegas-Andraca**, Tecnologicó de Monterrey, Campus Estado de México, and **Nelson Petulante**, Bowie State University.

Recent Advances in Discrete and Intuitive Geometry (Code: SS 31A), **Andras Bezdek**, Auburn University, **Ted Bisztriczky**, University of Calgary, and **Wlodek Kuperberg**, Auburn University (AMS-AAAS).

Recent Advances in the Analysis and Applications of Modern Splitting Methods (Code: SS 14A), **Abdul Q. M. Khaliq**, Middle Tennessee State University, **Qin Sheng**, Baylor University, and **Bruce Wade**, University of Wisconsin-Milwaukee.

Recent Developments in Algebraic Number Theory (Code: SS 9A), **Wen-Ching Winnie Li**, Pennsylvania State University, **Tong Liu**, Purdue University, and **Ling Long**, Iowa State University and Louisiana State University.

Research in Mathematics by Undergraduates and Students in Post-Baccalaureate Programs (Code: SS 17A), **Darren A. Narayan**, Rochester Institute of Technology, **Tamas Forgacs**, California State University Fresno, **Jobby Jacob** and **Carl V. Lutzer**, Rochester Institute of Technology, **Angel Pineda**, California State University Fullerton, and **Tamas Wiandt**, Rochester Institute of Technology (AMS-MAA-SIAM).

Ricci Curvature for Homogeneous Spaces and Related Topics (Code: SS 8A), **Megan Kerr**, Wellesley College, and **Tracy Payne**, Idaho State University.

Selmer Groups (Code: SS 53A), **Mirela Ciperiani**, University of Texas, and **Henri Darmon**, McGill University.

Set-Valued Optimization and Variational Problems with Applications (Code: SS 22A), **Akhtar A. Khan**, Rochester Institute of Technology, **Mau Nam Nguyen**, Portland State University, **Miguel Sama**, Universidad Nacional de Educacion a Distancia, Madrid, and **Christiane Tammer**, Martin-Luther-University of Halle-Wittenberg.

Studies in Interconnections among Parameters in Graph Theory, Combinatorics, and Discrete Geometry (Code: SS 39A), **Cong X. Kang** and **Eunjeong Yi**, Texas A&M University at Galveston.

Successes and Challenges in Teaching Mathematics (Code: SS 46A), **Ellina Grigorieva**, Texas Woman's University, and **Natali Hritonenko**, Prairie View A&M University.

Syzygies (Code: SS 27A), **Giulio Caviglia**, Purdue University, **Jason McCullough**, Rider University, and **Irena Peeva**, Cornell University.

The Scottish Book (Code: SS 15A), **Krystyna Kuperberg**, Auburn University, **R. Daniel Mauldin**, University of North Texas, and **Jan Mycielski**, University of Colorado.

Theory and Application of Reaction Diffusion Models (Code: SS 12A), **Jerome Goddard II**, Auburn University Montgomery, and **Ratnasingham Shivaji**, University of North Carolina Greensboro.

Topological Measures of Complexity: Inverse Limits, Entropy, and Structure of Attractors (Code: SS 28A), **Loribeth M. Alvin**, University of Denver, **Jan P. Boroński**, National Supercomputing Centre IT4Innovations, Ostrava, **James Keesling**, University of Florida, **Olga Lukina**, University of Illinois at Chicago, and **P. Oprocha**, AGH University of Science and Technology, Krakow.

What's New in Group Theory? (Code: SS 19A), **Arturo Magidin**, University of Louisiana at Lafayette, and **Elizabeth Wilcox**, Oswego State University.

Call for MAA Contributed Papers

The MAA Committee on Contributed Paper Sessions solicits contributed papers pertinent to the sessions listed below. Contributed Paper Session presentations are limited to fifteen minutes, except in the general session where they are limited to ten minutes. Each session room is equipped with a computer projector, an overhead projector, and a screen. Please note that the dates and times scheduled for these sessions remain tentative.

The deadline for submission of abstracts is Tuesday, September 16, 2014.

Contributed Paper Sessions with Themes

Activities, Demonstrations, and Projects that Enhance the Study of Undergraduate Geometry, organized by **Sarah Mabrouk**, Framingham State University; Sunday afternoon. This session invites presenters to share activities, demonstrations, and projects used to enhance the study of Euclidean or nonEuclidean geometry in undergraduate

geometry courses; presentations related to differential geometry, (low-level) graduate courses, and the Pythagorean Theorem should not be submitted. Presentations should include information about related topics, preliminary material that must be examined with students, and objectives and expected outcomes. Presenters discussing activities and demonstrations are encouraged to perform the activity or give the demonstration, if time and equipment allow, and to discuss the appropriateness of the activity or demonstration for the course level, learning environment, and class size. Presenters discussing projects are encouraged to address how the project was conducted, presented, and evaluated, including grading issues, if any, and the rubric used to appraise student work. Each presenter is encouraged to discuss how the activity, demonstration, or project fits into the course as well as changes made over time, the use of technology, if any, student reaction, and the effect of the activity, demonstration, or project on the students' understanding of related course material and geometry, in general.

Best Practices for Teaching the Introductory Statistics Course; organized by **Randall Pruim**, Calvin College; **Scott Alberts**, Truman State University; and **Patti Frazer Lock**, St. Lawrence University; Saturday afternoon. Much attention has been focused in recent years on improving student learning in the introductory statistics course. We invite submissions that provide details about learning activities, technologies, resources, or teaching methods that have been used to successfully improve student learning in Intro Stats. We particularly encourage submissions related to teaching introductory statistics using nonconventional data, models, and computing (e.g., "big" data, web scraping, etc.). We also welcome presentations about overcoming the challenges faced by mathematicians, often with little formal training in statistics, who find themselves teaching statistics. Presenters will be considered for the Dex Whittinghill Award for Best Contributed Paper. Sponsored by the SIGMAA on Statistics Education.

Cartography and Mathematics: Imaging the World Around Us, organized by **Emek Kose** and **Casey Douglas**, St. Mary's College of Maryland; Monday morning. Cartography has used and inspired different kinds of mathematics for centuries, including but not limited to questions in real analysis, complex analysis, differential geometry, and Riemannian geometry. Modern incarnations of these phenomena make use of exciting topics, too, such as imaging, mirror design, spatial statistics, and optics. We welcome talks from a variety of fields that involve, generalize, or are inspired by cartographic projections and our quest to visualize the world around us.

Collaborations between Two-Year and Four-Year Institutions that Create Pathways to a Math Major, organized by **Nancy Sattler**, Terra State Community College; **Judy Ackerman**, Montgomery College Rockville Campus; and **Elizabeth Teles**, National Science Foundation; Monday morning. As more students start their college education at two-year colleges prior to transferring to a four-year program, it is increasingly important for two-year and four-year mathematics departments to collaborate to create student pathways to the mathematics major and for alignment of credit courses. Models that describe collaborative strategies and programs between two-year and four-year faculty and institutions to attract and retain community college transfers should be submitted. Joint submissions by a faculty member and a student are especially encouraged. Sponsored by the Committee on Two-Year Colleges (CTYC) and the Curriculum Renewal Across the First Two Years (CRAFTY).

Cryptology for Undergraduates, organized by **Robert Lewand**, Goucher College, and **Chris Christensen**, Northern Kentucky University; Saturday morning. In increasing numbers, cryptology courses are being developed to serve the needs of undergraduate mathematics and computer science majors. For mathematics majors cryptology fits into the undergraduate curriculum in much the same way that number theory does. In addition, cryptology is appearing as a topic in mathematics courses for nonmajors, as it is a hook to interest these students in mathematics. This session solicits presentations that address topics appropriate for undergraduate cryptology courses for mathematics or computer science majors, or presentations of cryptological topics that could interest and motivate nonmathematics majors.

Discovery and Insight in Mathematics, organized by **Dan Sloughter**, Furman University, and **Bonnie Gold**, Monmouth University; Tuesday afternoon. One new development in the philosophy of mathematics that mathematicians should welcome is an interest in the philosophy of mathematics as actually practiced by mathematicians. This session invites talks addressing philosophical issues concerning two related topics: how mathematics is discovered, and the role of insight in mathematical understanding and discovery. Epistemology studies how we come to know things. A distinction has been made between methods of discovery and methods of justification: that is, the way one discovers a mathematical truth—a conjecture, for example—may be quite different from how it is later justified (by a proof). What are the methods and grounds for such discoveries? What is the role insight plays in these discoveries? How do interconnections between mathematical concepts or subjects lead to discoveries? Talks addressing any of these issues within the philosophy of mathematics are appropriate for this session.

Papers on other topics in the philosophy of mathematics will be considered as time permits. Sponsored by the SIGMAA on the Philosophy of Mathematics.

Ethnomathematics: A Tribute to Marcia Ascher, organized by **Ximena Catepillan**, Millersville University; **Amy Shell-Gellasch**, Montgomery College; and **Janet Beery**, University of Redlands; Monday morning. Ethnomathematics, the study of mathematical aspects of the cultures of indigenous peoples, has been an active area of research for many decades. As more institutions strive to present multicultural offerings to their students, courses on or incorporating ethnomathematics are becoming more popular. This session features talks that present research in ethnomathematics or well-tested ideas for its use in teaching. The session is a tribute to Marcia Ascher (April 23, 1935–June 11, 2013), who devoted much of her

career and life to the development of ethnomathematics. Sponsored by the SIGMAA on the History of Mathematics.

First-Year Calculus: Fresh Approaches for Jaded Students, organized by **Bob Sachs**, George Mason University, and **Caren Diefenderfer**, Hollins University; Tuesday afternoon. The majority of first-year college students signing up for calculus had a previous encounter with the subject during high school. These new college students start out in calculus 1 (or even calculus 2) having seen much of the material of the course, but with weakness or lack of (or perhaps an unwarranted) confidence in some areas. As such, this audience poses special challenges to the college instructor. This session seeks presenters that will share innovative approaches to engage this audience in first or second semester calculus. Such responses may be curricular, say through a reorganization or approach to the material, or structural, such as innovative approaches to placement. The session is in part inspired by and seeks to complement the MAA's NSF-sponsored project on Characteristics of Successful Programs in College Calculus. Sponsored by the SIGMAA on Teaching Advanced High School Mathematics.

Helping Students See Beyond Calculus, organized by **David Strong**, Pepperdine University; **Courtney Davis**, Pepperdine; **Angela Spalsbury**, Youngstown State University; and **James Tanton**, MAA; Sunday afternoon. Society needs more and better mathematics and science students. Many talented and promising students lose interest in mathematics—some never take a single mathematics course in college—because they never experience the beauty and importance of the many other areas of mathematics beyond calculus. Indeed, many high school students think of mathematics simply as calculus and the topics leading to calculus. Students would benefit enormously from more exposure to other areas of mathematics before leaving high school.

This session, a first step toward this goal, will be a forum for sharing presentations which are all of the following: an introduction to a specific mathematical idea or application; accessible to high school calculus students; certainly interesting, hopefully entertaining, possibly captivating; self-contained; less than 45 minutes; available online (for now, posted at their authors' own websites); comprised of slides (e.g., power points), video or audio clips, tools for experimentation and visualization, etc.;and may include worksheets of problems for students to think about or work on.

High school teachers (or anyone else) could download, or access online, the presentations and supporting materials to use in their classes in the weeks after the AP exam. Speakers in this session will share a condensed (10–15 minutes) version of their presentation.

Humor and Teaching Mathematics, organized by **Semra Kilic-Bahi**, Colby-Sawyer College; **Gizem Karaali**, Pomona College; and **Debra Borkovitz**, Wheelock College; Saturday morning. Humor is a powerful teaching tool. It can be used to make a course more interesting, to introduce a topic or a concept, to emphasize a misconception, or to help recall learned material. Furthermore, it can help build relationships and classroom communities by easing stressful situations, reducing anxiety levels, enhancing communication, and making the classroom a place where students want to be. This session will showcase presentations on how humor and math can be combined and how humor can be used in the classroom to enhance learning. We particularly encourage submissions about ideas and techniques that have been tested in the classroom and have had a demonstrated effect on student learning and attitudes, though more theoretical or tentative approaches are also welcome. This session specifically emphasizes the place of humor in the mathematics classroom, but outstanding submissions about other facets of the relationship of mathematics and humor will also be considered.

Incorporating Formal Symbolic Reasoning into Mathematics Courses, organized by **Christopher Shaw** and **Daniel Jordan**, Columbia College Chicago; Sunday morning. Techniques from symbolic logic enrich the undergraduate curriculum at all levels. Courses in quantitative reasoning or liberal arts mathematics often include units on symbolic logic or basic concepts of set theory: for example, one representative text includes a section that begins with basic truth tables and concludes with a study on the validity of syllogisms. Geometry courses use formal rules of inference, proof by contradiction drives inference in statistics courses, computer science classes depend on logic for control flow, and Venn diagrams appear in many areas. Finally, more advanced courses often include a primer on the logical foundations of proof techniques. However it can be challenging to develop coherent curricula that help students make direct connections between formal symbolic reasoning and the other areas of mathematics they are studying. Another challenge is that formal logic is not universally taught in secondary schools, creating a wide disparity among students' preparation.

Speakers in this session should discuss creative ways of incorporating the study of formal symbolic logic into mathematics courses, the benefits of doing so, or ways to address challenges. The organizers particularly welcome presentations from practitioners that include specific activities or interesting problems that could be used in the classroom.

Infusing Quantitative Literacy into Mathematics and Nonmathematics Courses, organized by **Andrew Miller**, Belmont University; **Aaron Montgomery**, Central Washington University; and **Gary Franchy**, Mott Community College; Tuesday afternoon. Quantitative literacy (QL) can be described as the ability to adequately use elementary mathematical tools to interpret and manipulate quantitative data and ideas that arise in an individual's private, civic, and work life. Like reading and writing literacy, quantitative literacy is a habit of mind that is best formed by exposure in many contexts. Many institutions have entire courses devoted to QL, while others embed QL learning objectives into traditional mathematics courses or nonmathematics courses. We invite talks that describe projects, applications, modules, or entire courses that help students achieve quantitative literacy. Since QL is inherently interdisciplinary, we encourage discussion of material that may appear in or be linked to nonmathematics courses. Also, since QL goals are often neglected

in advanced mathematics courses, we welcome material that appears in mathematics courses at the calculus level and above. Preference will be given to talks that present innovative content or courses, novel contexts, well-developed assessment of objectives, or otherwise advance the national dialogue on QL. Sponsored by the SIGMAA on QL.

Innovative and Effective Ways to Teach Linear Algebra, organized by **David Strong**, Pepperdine University; **Gilbert Strang**, MIT; and **Megan Wawro**, Virginia Tech; Sunday morning. Linear algebra is one of the most interesting and useful areas of mathematics, because of its beautiful and multifaceted theory, as well as the enormous importance it plays in understanding and solving many real world problems. Consequently many valuable and creative ways to teach its rich theory and its many applications are continually being developed and refined. This session will serve as a forum in which to share and discuss new or improved teaching ideas and approaches. These innovative and effective ways to teach linear algebra include, but are not necessarily limited to: (1) hands-on, in-class demos; (2) effective use of technology, such as Matlab, Maple, Mathematica, Java Applets, or Flash; (3) interesting and enlightening connections between ideas that arise in linear algebra and ideas in other mathematical branches; (4) interesting and compelling examples and problems involving particular ideas being taught; (5) comparing and contrasting visual (geometric) and more abstract (algebraic) explanations of specific ideas; and (6) other novel and useful approaches or pedagogical tools.

Inquiry-Based Learning in First-Year and Second-Year Courses, organized by **Dana Ernst**, Northern Arizona University; **Angie Hodge**, University of Nebraska at Omaha; and **Theron Hitchman**, University of Northern Iowa; Sunday morning. An inquiry-based learning (IBL) approach challenges students to create mathematics by providing tasks requiring them to conjecture, experiment, explore, and solve problems. Rather than showing facts or a clear, smooth path to a solution, the instructor guides students via well-crafted problems through an adventure in mathematical discovery. There is a growing body of evidence that supports the claim that IBL techniques are effective for teaching mathematics and for fostering positive attitudes about mathematics. While there is a long tradition of using IBL in proof-based classes, it is often a challenge to bring an inquiry-based pedagogy into classes with significant content expectations, a heavy computational focus, or a large number of students.

We invite papers that address the use of IBL in first and second year courses. We especially encourage topics about the use of IBL in college algebra, pre-calculus, calculus, linear algebra, and differential equations. Claims made should be supported by data (student responses, test scores, survey results, etc.) or anecdotal evidence.

Papers from the session may be considered for a special issue of PRIMUS. Sponsored by PRIMUS: Problems, Resources, and Issues in Undergraduate Mathematics Studies.

Mathematics and Sports, organized by **R. Drew Pasteur**, College of Wooster, and **John David**, Virginia Military Institute; Saturday afternoon. The expanding availability of play-by-play statistics and video-based spatial data, for professional and some collegiate sports, is leading to innovative kinds of research, using techniques from various areas of the mathematical sciences. By modeling the outcome distributions in certain situations, researchers can develop new metrics for player or team performance in various aspects of a sport, comparing actual results to expected values. Such work often has implications for strategic game management and personnel evaluation. Classic areas of study, such as tournament design, ranking methodology, forecasting future performance, insight into rare or record events, and physics-based analysis, also remain of interest. This session will include both presentations of original research and expository talks; topics related to the use of sports applications in curriculum are welcome. With a broad audience in mind all talks are requested to be accessible to mathematics majors. Undergraduates and their mentors are particularly encouraged to submit abstracts for consideration.

Mathematics and the Arts, organized by **Douglas Norton**, Villanova University; Saturday morning and afternoon. An appreciation of the connections between mathematics and the arts explores and extends those aspects of our discipline that complement number and rational thought at its center: pattern, shape, and an unmistakable sense of aesthetics. We invite those who work in or only occasionally visit some of the many areas at the intersection of mathematics and the arts to report on these excursions: artists, mathematicians, educators, those claiming hyphenated versions of these titles, and those eschewing classification altogether. We particularly encourage contributions from those who have incorporated into their courses math-art concepts or material that may be appropriate to use with our majors beyond the introductory level. Of course, topics from more elementary or more advanced mathematics, for the classroom or in practice, are always welcome. Sponsored by the SIGMAA on Mathematics and the Arts.

Mathematics Experiences in Business, Industry, and Government, organized by **Carla Martin**, Department of Defense; **Phil Gustafson**, Mesa State University; and **Michael Monticino**, University of North Texas; Sunday afternoon. The MAA Business, Industry, and Government Special Interest Group (BIG SIGMAA) provides resources and a forum for mathematicians working in Business, Industry, and Government (BIG) to help advance the mathematics profession by making connections, building partnerships, and sharing ideas. BIG SIGMAA consists of mathematicians in BIG as well as faculty and students in academia who are working on BIG problems.

Mathematicians, including those in academia, with BIG experience are invited to present papers or discuss projects involving the application of mathematics to BIG problems. The goal of this contributed paper session is to provide a venue for mathematicians with experience in business, industry, and government to share projects and mathematical ideas in this regard. Anyone interested in learning more about BIG practitioners, projects, and

issues, will find this session of interest. Sponsored by the SIGMAA on Mathematics in Business and Industry.

Original Sources and Archives in the Classroom, organized by **Amy Shell-Gellasch**, Montgomery College, and **Dominic Klyve**, Central Washington University; Tuesday morning. In the last few years, the number of resources in the history of mathematics available on the Internet has skyrocketed. This makes it very easy for the math educator to include original and historical sources and materials into their mathematics classroom. This session invites talks that show how to use online materials such as original sources, archives, museum pieces, correspondence, and much more to supplement and enhance mathematics courses.

Perspectives and Experiences on Mentoring Undergraduate Students in Research, organized by **Aihua Li**, Montclair State University; **Thomas Hagedorn**, College of New Jersey; and **Jan Rychtar**, The University of North Carolina at Greensboro; Saturday morning. In recent years, mathematics faculty members have become increasingly interested in mentoring undergraduate research. This paper session will provide an opportunity for faculty mentors to 1) discuss and exchange ideas on current trends and best practices in mentoring undergraduate research; and 2) share their experiences in directing undergraduate level research activities. We invite talks addressing any issue about mentoring undergraduate research. We especially encourage talks that address the following topics: how to get started, challenges and benefits of mentoring undergraduate research, how to choose a good topic for undergraduate research, managing student work and expectations (from recruitment to final reports), writing and publishing with undergraduates, potential pitfalls and how to overcome them during the mentoring journey, and how to help students develop independence in doing research.

We welcome undergraduate research mentors to share with other participants their experiences, ideas, stories of successful or unsuccessful attempts, and effective approaches to working with undergraduate students. The presentations are expected to be scholarly in nature and present evidence supporting the success of the described approaches.

This session serves as a follow-up event for the Regional Faculty Workshop on REU Issues (RFWREU) held in New Jersey in May 2013. Participants from RFWREU are especially encouraged to present in this session. This session is also sponsored by the journal PRIMUS. Papers arising from this session, along with papers from RFWREU participants, may be considered for a special issue of PRIMUS on mentoring undergraduate research.

Program and Assessment Implications of Common Core State Standards Implementation, organized by **William Martin**, North Dakota State University; **Bonnie Gold**, Monmouth University; and **John Carter**, Westlake High School; Monday afternoon. The Common Core State Standards for Mathematics (CCSS) have been widely adopted and implemented nationally. Mathematics departments share responsibility with teacher education programs to prepare future teachers who are ready to teach school mathematics so that their students can meet both the content and mathematical practices standards. Mathematics faculty also collaborate with the K–12 system to ensure a smooth transition from school to higher education, one of the primary purposes of the CCSS. We encourage faculty to disseminate information about their experiences with the role of mathematics departments in the implementation of the CCSS mathematics standards by inviting contributed papers that describe projects in undergraduate mathematics and teacher education programs that assess how well their pre-service teacher education candidates are prepared with the knowledge and skills necessary to implement the CCSS for mathematics content and practices; discuss work with K–12 partners to implement the CCSS math standards; report findings of such projects; or describe faculty and departmental responses to such findings.

Papers are solicited from any individuals or groups actively involved in assessment and preparation of candidates to effectively teach mathematics in Grades K–12. Sponsored by the MAA Assessment Committee and MAA COMET.

Research on the Teaching and Learning of Undergraduate Mathematics, organized by **Karen Keene**, North Carolina State University; **Timothy Fukawa-Connelly**, Drexel University; and **Michelle Zandieh**, Arizona State University; Sunday morning and afternoon. This session presents research reports on undergraduate mathematics education. The session will feature research in a number of mathematical areas including linear algebra, advanced calculus, abstract algebra, and mathematical proof. The goals of this session are to foster high-quality research in undergraduate mathematics education, to disseminate well-designed educational studies to the greater mathematics community, and to transform theoretical work into practical consequences in college mathematics. Examples of such types of research include rigorous and scientific studies about students' mathematical cognition and reasoning, teaching practice in inquiry-oriented mathematics classrooms, design of research-based curricular materials, and professional development of mathematics teachers, with intention to support and advance college students' mathematical thinking and activities. The presentation should report results of completed research that builds on the existing literature in mathematics education and employs contemporary educational theories of the teaching and learning of mathematics. The research should use well-established or innovative methodologies (e.g., design experiment, classroom teaching experiment, and clinical interview, with rigorous analytic methods) as they pertain to the study of undergraduate mathematics education. We also welcome preliminary reports on research projects in early stages of development or execution. Sponsored by the SIGMAA on Research in Undergraduate Mathematics Education.

Revitalizing Complex Analysis at the Undergraduate Level, organized by **Russell Howell**, Westmont College; **Paul Zorn**, St. Olaf College; and **Alan Noell**, Oklahoma State University; Saturday afternoon. Complex analysis, despite its beauty and power, seems to have has lost some of the prominence it once enjoyed in undergraduate

mathematics, science, and engineering. Thanks to funding from the NSF, a national dialog has begun with the intention of remedying this situation. A team of people will convene for the purpose of giving some initial recommendations, but input from the broader mathematical community is solicited.

Papers at this session should be scholarly in nature, but collectively address a wide range of questions: What are the essential components of an undergraduate complex analysis class from mathematical and scientific standpoints? What technologies seem to be promising? What pedagogical ideas have borne fruit? In general, what innovative approaches might be suggested in teaching the subject?

The Scholarship of Teaching and Learning in Collegiate Mathematics, organized by **Jackie Dewar**, Loyola Marymount University; **Thomas Banchoff**, Brown University; **Curtis Bennett**, Loyola Marymount University; **Pam Crawford**, Jacksonville University; and **Edwin Herman**, University of Wisconsin Stevens Point; Saturday morning and afternoon. In the scholarship of teaching and learning, faculty bring disciplinary knowledge to bear on questions of teaching and learning and systematically gather evidence to support their conclusions. Work in this area includes investigations of the effectiveness of pedagogical methods, assignments, or technology, as well as probes of student understanding.

The goals of this session are to (1) feature scholarly work focused on the teaching of post-secondary mathematics, (2) provide a venue for teaching mathematicians to make public their scholarly investigations into teaching/learning and (3) highlight evidence-based arguments for the value of teaching innovations or in support of new insights into student learning.

Appropriate for this session are preliminary or final reports of post-secondary classroom-based investigations of teaching methods, student learning difficulties, curricular assessment, or insights into student (mis)understandings. Abstract submissions should have a clearly stated question that was or is under investigation and should give some indication of the type of evidence that has been gathered and will be presented. For example, papers might reference the following types of evidence: student work, participation or retention data, pre/post tests, interviews, surveys, think-alouds, etc.

Statistics Education beyond the Introductory Statistics Course, organized by **Randall Pruim**, Calvin College; **Scott Alberts**, Truman State University; and **Patti Frazer Lock**, St. Lawrence University; Sunday afternoon. The introductory noncalculus-based statistics course ("Intro Stats") is one of the most commonly taught courses on university campuses, and much attention has been focused on improving student learning in this course. This session is focused on the rest of the undergraduate statistics curriculum. We invite submissions that provide details about learning activities, technologies, resources, or teaching methods that have been used to teach statistics outside the Intro Stats course. In addition to discussions related to calculus-based first courses in statistics, "Stat 2", "MathStat", and other courses in the statistics curriculum, we encourage submissions related to teaching statistics through internships, undergraduate research experiences, and capstone courses, as well as efforts to partner with other disciplines to ensure that the statistics learned in Intro Stats (and other courses) is affecting the data analyses done in these disciplines. Presentations should address the objectives and effectiveness of the described activities. Presenters will be considered for the Dex Whittinghill Award for Best Contributed Paper. Sponsored by the SIGMAA on Statistics Education.

Teaching Inquiry, organized by **Brian Katz**, Augustana College, and **Elizabeth Thoren**, University of California Santa Barbara; Tuesday afternoon. We need to teach our students more than the content of our courses; we need to teach them how to ask and explore questions: a skill that we call mathematical inquiry. This kind of learning is challenging for students and teachers and requires new methods; sharing these ideas can help us all improve. In this session, we will explore the ways that mathematics instructors support students' mathematical inquiry as well as the ways we prepare students to ask and investigate mathematical questions after they leave the classroom.

This session will include scholarly presentations on (1) successful methods or assignments designed to teach students to ask and explore mathematical questions and (2) the consequences of teaching mathematical inquiry for the students' skills, attitudes, and beliefs. We especially encourage talks about helping students begin to ask novel questions as part of undergraduate research, about mathematics education research concerning student questioning behaviors, and about teaching nonmajors to ask good mathematical questions. We also welcome courses from the inquiry-based learning tradition, but ask that they emphasize teaching students to ask questions.

Teaching Proof Writing Techniques within a Content-Based Mathematics Course, organized by **Kristi Meyer**, Wisconsin Lutheran College, and **Jessie Lenarz**, St. Catherine University; Tuesday morning. At many smaller undergraduate institutions, it is not possible to offer a dedicated introductory proofs course. Therefore, a content-based course is often used to introduce proof writing techniques. Depending on the course chosen and the method of instruction used, student success can vary widely from course to course. In this session, we seek to gain insight from those who have successfully implemented proof writing techniques in a content-based course. Papers focusing on methods of instruction, including in-class activities, methods of assessment—both formative and summative—and overall course design are welcome. Discussion of the interaction between content-based instruction and proof writing techniques is particularly encouraged.

Technology, the Next Generation: Integrating Tablets into the Mathematics Classroom, organized by **Kevin Charlwood** and **Janet Sharp**, Washburn University; Saturday afternoon. Presenters will describe effective and ineffective classroom integration of electronic tablets into university mathematics courses. The presentations will include specific classroom examples of efforts to harness the dramatic power of an electronic tablet. Presentations will describe mathematical objectives to have been

achieved, evidence of levels of success among students, and a rationale for the decision to integrate technology into the learning experiences.

The Times They are a Changin': Successful Innovations in Developmental Mathematics Curricula and Pedagogy, organized by **Suzanne Dorée**, Augsburg College; **Joanne Peeples**, El Paso Community College; **Donald Small**, USMA; **Bruce Yoshiwara**, Los Angeles Pierce College; and **Chris Oehrlein**, Oklahoma City Community College; Monday morning. Developmental mathematics education has captured the nation's attention as critical to student success in college and life. The mathematics community is working vigorously to redress high failure rates, low student preparation for subsequent courses, and routine requirements for multiple-semester sequences for reasonably prepared students. Increasing pressures to help students better prepare for college mathematics in less time and/or with dwindling resources calls for new, creative solutions. For example, there are emerging curricula tailored for different student major/career pathways, novel uses of online student-learning tools, and interesting coprograms that support student learning and persistence.

This session invites speakers who have implemented successful innovative curricula, pedagogy, or student support programs for developmental mathematics. Talks should briefly summarize the key changes made, provide specific evidence of student success, and highlight information or advice that would be helpful for other departments who might implement the changes. Talks examining what research on mathematics education tells us about developmental mathematics education are also appropriate. This session welcomes speakers from two-year colleges, speakers implementing solutions in a four-year college context, or partnerships between two-year and four-year colleges. Sponsored by the Committee on Two-Year Colleges (CTYC) and the Curriculum Renewal Across the First Two Years (CRAFTY)

Trends in Undergraduate Mathematical Biology Education, organized by **Timothy Comar**, Benedictine University; Monday afternoon. Several recent reports emphasize that aspects of biological research are becoming more quantitative and that life science students, including pre-med students, should be introduced to a greater array of mathematical, statistical, and computational techniques and to the integration of mathematics and biological content at the undergraduate level. Mathematics majors also benefit from coursework at the intersection of mathematics and biology because there are interesting, approachable research problems and mathematics students need to be trained to collaborate with scientists in other disciplines, particularly biology.

Topics may include scholarly work addressing the issues related to the design of effective biomathematics course content, courses and curricula, the integration of biology into mathematics courses, student recruitment efforts, the gearing of content toward pre-med students, undergraduate research projects, effective use of technology in biomathematics courses, preparation for graduate work in biomathematics and computational biology or for medical careers, and assessment issues. Sponsored by the SIGMAA on Mathematical and Computational Biology.

USE Math: Undergraduate Sustainability Experiences in the Mathematics Classroom, organized by **Ben Galluzzo**, Shippensburg University, and **Corrine Taylor**, Wellesley College; Tuesday morning. Humanity continually faces the task of how to balance human needs against the world's resources, while operating within the constraints imposed by the laws of nature. Mathematics helps us better understand these complex issues that span disciplines: from measuring energy and other resources, to understanding variability in air and water quality, to modeling climate change. Moreover, these and other real world driven sustainability topics have the potential for motivating students to pursue STEM courses and fields of study more deeply. This session seeks proposals from faculty who have integrated sustainability-focused activities, projects, or modules into the college mathematics curriculum, in particular in introductory mathematics classes and statistics courses. Abstracts of accepted papers will be published on the SIGMAA-EM website, and authors will be encouraged to submit classroom-ready materials for broad dissemination on the Mathematics/QR Disciplinary page on the Sustainability Improves Student Learning (SISL) website (`http://serc.carleton.edu/sisl/sustain_in_math.html`). Sponsored by the SIGMAA on Environmental Mathematics.

Using Flipping Pedagogy to Engage Students in Learning Mathematics, organized by **Jean McGivney-Burelle**, **Larissa Schroeder**, **Fei Xue**, and **John Williams**, University of Hartford; Tuesday morning. While the expression "flipping a course" is relatively new, this pedagogical strategy has been around for a number of years. Tenets that underlie this type of pedagogy are that basic definitions, theorems, and examples can be delivered via videos or readings prior to class and that time in class can be better spent assimilating and applying knowledge on more complex problems and activities. Recently, inverted instruction or "flipping" pedagogy has gained traction in university mathematics departments. For this session we invite participants to submit proposals about their experiences teaching inverted mathematics courses. We welcome descriptions of curriculum materials, innovative instructional designs, technology, and assessment strategies to support students' engagement and learning in flipped classrooms. Accounts of different models of flipping pedagogy for small and large classes, and in introductory through advanced courses, are also welcome. Reports of results from preliminary studies or comprehensive research projects on flipping pedagogy will also be suitable for this session.

Wavelets in Undergraduate Education, organized by **Caroline Haddad**, SUNY Geneseo; **John Merkel**, Oglethorpe University; and **Edward Aboufadel**, Grand Valley State University; Monday afternoon. Wavelets are functions that satisfy certain mathematical properties and are used to represent data or other functions. They work extremely well in analyzing data with finite domains having different scales or resolutions. Interesting applications include digital image processing, FBI fingerprint compression, the

design of medical equipment, and the detection of potholes. Wavelets have typically been studied at the graduate level, but are making their way into the undergraduate curriculum. We are interested in presentations that effectively incorporate wavelets in an innovative way at the undergraduate level. This may include an undergraduate course in wavelets; a topic on wavelets in some other course using, but not limited to, hands-on demonstrations, projects; labs that utilize technology such as Matlab, Mathematica, Maple, Java applets, etc.; or research opportunities for undergraduates.

Well-Designed Online Assessment: Well-Formed Questions, Discovery-Based Explorations, and Their Success in Improving Student Learning, organized by **Paul Seeburger**, Monroe Community College, and **Matthew Leingang**, New York University; Monday afternoon. Online delivery of homework and other assessments in mathematics courses has become standard. Many problems have been taken from textbooks and recreated in the context of a variety of online learning systems. Unfortunately, there is often something lost in this process, reducing once open-ended questions expecting a series of clearly written steps to a single answer blank, or sometimes just a multiple-choice response.

It would be arguably more effective to develop online questions and explorations that are pedagogically well-formed, and which take full advantage of the online environment. These would not only more accurately assess student knowledge but also help students to develop proper understanding and clear procedures.

We invite papers describing online questions or activities that have been successful in helping students learn particular learning objectives. We specifically solicit (and will prefer in selection) papers that assess the impact of these online activities on student learning. Both qualitative and quantitative results are welcome.

Preference will also be given to papers with problems, explorations, or activities that can be easily adopted in a broad range of institutions, or accessed by a wide range of devices (mobile phones, tablets, laptops, desktops, etc.). Sponsored by the SIGMAA on Mathematics Instruction Using the WEB.

What Makes a Successful Math Circle: Organization and Problems, organized by **Philip Yasskin**, Texas A&M University; **Tatiana Shubin**, San Jose State University; **Paul Zeitz**, University of San Francisco; and **Katherine Morrison**, University of Northern Colorado; Sunday morning. A mathematics circle is an enrichment activity for K–12 students or their teachers, which brings them into direct contact with mathematics professionals, fostering a passion and excitement for deep mathematics in the participants. It is usually a weekly or monthly activity, but it can also be an intensive summer experience. There are many factors that lead to a successful math circle for either students or teachers. Talks are invited which address either the successful organization of a math circle or a problem or topic that was successful at your math circle. Sponsored by the SIGMAA Math Circles for Students and Teachers.

General Contributed Paper Sessions, organized by **Kristen Meyer**, Wisconsin Lutheran College; **Bem Cayco**, San Jose State University; and **Kimberly Presser**, Shippensburg University of Pennsylvania; Saturday, Sunday, Monday, and Tuesday mornings and afternoons. These sessions accept contributions in all areas of mathematics, curriculum, and pedagogy. When you submit your abstract you will be asked to classify it under one of the following areas: *Assessment*; *History or Philosophy of Mathematics*; *Interdisciplinary Topics in Mathematics*; *Mathematics and Technology*; *Mentoring*; *Modeling or Applications*; *Outreach*; *Probability or Statistics*; *Research in Algebra; Research in Analysis*; *Research in Applied Mathematics*; *Research in Geometry*; *Research in Graph Theory*; *Research in Linear Algebra*; *Research in Logic or Foundations*; *Research in Number Theory*; *Research in Topology*; *Teaching or Learning Advanced Mathematics*; *Teaching or Learning Calculus*; *Teaching or Learning Developmental Mathematics*; *Teaching or Learning Introductory Mathematics*; or *Assorted Topics*.

Submission Procedures for MAA Contributed Paper Abstracts

Abstracts may be submitted electronically at `http://jointmathematicsmeetings.org/meetings/abstracts/abstract.pl?type=jmm`. Simply fill in the number of authors, click "New Abstract", and then follow the step-by-step instructions. **The deadline for abstracts is Tuesday, September 16, 2014.**

Each participant may give at most one talk in any one themed contributed paper session or the general contributed paper session. If your paper cannot be accommodated in the session in which it is submitted, it will automatically be considered for the general session.

The organizer(s) of your session will automatically receive a copy of the abstract, so it is not necessary for you to send it directly to the organizer. All accepted abstracts are published in a book that is available to registered participants at the meeting. Questions concerning the submission of abstracts should be addressed to `abs-coord@ams.org`.

Washington, District of Columbia

Georgetown University

March 7–8, 2015

Saturday – Sunday

Meeting #1107

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: January 2015
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: March 2015
Issue of *Abstracts*: Volume 36, Issue 2

Deadlines

For organizers: Expired
For abstracts: January 20, 2015

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Frederico Rodriguez Hertz, Pennsylvania State University, *Title to be announced.*

Nancy Hingston, The College of New Jersey, *Title to be announced.*

Simon Tavaré, Cambridge University, *Title to be announced* ().

Yitang Zhang, University of New Hampshire, *Title to be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at http://www.ams.org/cgi-bin/abstracts/abstract.pl.

Crossing Numbers of Graphs (Code: SS 3A), **Paul Kainen**, Georgetown University.

Quantum Algebras, Representations, and Categorifications (Code: SS 2A), **Sean Clark** and **Weiqiang Wang**, University of Virginia.

Topology in Biology (Code: SS 4A), **Paul Kainen**, Georgetown University.

Within-Host Disease Modeling (Code: SS 1A), **Stanca Ciupe**, Virginia Polytechnic Institute, and **Sivan Leviyang**, Georgetown University.

East Lansing, Michigan

Michigan State University

March 13–15, 2015

Friday – Sunday

Meeting #1108

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: January 2015
Program first available on AMS website: January 29, 2015
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: Volume 36, Issue 2

Deadlines

For organizers: August 26, 2014
For abstracts: January 20, 2015

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Philippe Di Francesco, University of Illinois, *Title to be announced.*

Alexander Furman, University of Illinois at Chicago, *Title to be announced.*

Vera Mikyoung Hur, University of Illinois at Urbana-Champaign, *Title to be announced.*

Mihnea Popa, University of Illinois at Chicago, *Title to be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at http://www.ams.org/cgi-bin/abstracts/abstract.pl.

Approximation Theory in Signal Processing and Computer Science (Code: SS 5A), **Mark Iwen**, Michigan State University, **Rayan Saab**, University of California San Diego, and **Aditya Viswanathan**, Michigan State University.

Arithmetic of Hyperelliptic Curves (Code: SS 3A), **Tony Shaska**, Oakland University.

Fractional Calculus and Nonlocal Operators (Code: SS 1A), **Mark M. Meerschaert** and **Russell Schwab**, Michigan State University.

Random Fields and Long Range Dependence (Code: SS 2A), **Mark M. Meerschaert** and **Yimin Xiao**, Michigan State University.

Stochastic Partial Differential Equations and Applications (Code: SS 4A), **Leszek Gawarecki**, Kettering University, and **Vidyadhar Mandrekar**, Michigan State University.

Huntsville, Alabama

University of Alabama in Huntsville

March 27–29, 2015

Friday – Sunday

Meeting #1109

Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: January 2015
Program first available on AMS website: February 11, 2015
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: Volume 36, Issue 2

Deadlines

For organizers: August 20, 2014
For abstracts: February 4, 2015

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at http://www.ams.org/cgi-bin/abstracts/abstract.pl.

Fractal Geometry and Ergodic Theory (Code: SS 1A), **Mrinal Kanti Roychowdhury**, University of Texas-Pan American.

Las Vegas, Nevada

University of Nevada, Las Vegas

April 18–19, 2015

Saturday – Sunday

Meeting #1110

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: February 2015
Program first available on AMS website: March 5, 2015
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: Volume 36, Issue 2

Deadlines

For organizers: September 18, 2014
For abstracts: February 24, 2015

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Joel Hass, University of California, Davis, *Title to be announced.*

Ko Honda, University of California, Los Angeles, *Title to be announced.*

Brendon Rhoades, University of California, San Diego, *Title to be announced.*

Bianca Viray, Brown University, *Title to be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at http://www.ams.org/cgi-bin/abstracts/abstract.pl.

Inverse Problems and Related Mathematical Methods in Physics (Code: SS 1A), **Hanna Makaruk**, Los Alamos National Laboratory, and **Robert Owczarek**, University of New Mexico, Albuquerque.

Stochastic Analysis and Rough Paths (Code: SS 2A), **Fabrice Baudoin**, Purdue University, **David Nualart**, University of Kansas, and **Cheng Ouyang**, University of Illinois at Chicago.

Porto, Portugal

University of Porto

June 10–13, 2015

Wednesday – Saturday

Meeting #1111

First Joint International Meeting involving the American Mathematical Society (AMS), the European Mathematical Society (EMS), and the Sociedade de Portuguesa Matematica (SPM).
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: Not applicable

Deadlines

For organizers: To be announced
For abstracts: To be announced

Invited Addresses

Marcus du Sautoy, University of Oxford, *Title to be announced.*

Rui Loja Fernandes, University of Illinois at Urbana-Champaign, *Title to be announced.*

Irene Fonseca, Carnegie Mellon University, San Diego, *Title to be announced.*

Annette Huber-Klawitter, Albert-Ludwigs-Universität, *Title to be announced.*

Mikhail Khovanov, Columbia University, *Title to be announced.*

André Neves, Imperial College London, *Title to be announced.*

Sylvia Serfaty, Massachusetts Institute of Technology, San Diego, *Title to be announced.*

Marcelo Viana, Instituto de Mátematica Pura Aplicada, *Title to be announced.*

Chicago, Illinois

Loyola University Chicago

October 3–4, 2015

Saturday – Sunday

Meeting #1112

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: June 2015
Program first available on AMS website: August 20, 2015
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: Volume 36, Issue 4

Deadlines

For organizers: March 10, 2015
For abstracts: August 11, 2015

Memphis, Tennessee

University of Memphis

October 17–18, 2015
Saturday – Sunday

Meeting #1113
Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: August 2015
Program first available on AMS website: September 3, 2015
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: Volume 36, Issue 3

Deadlines
For organizers: March 17, 2015
For abstracts: August 25, 2015

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Special Sessions
If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at http://www.ams.org/cgi-bin/abstracts/abstract.pl.

Computational Analysis (Code: SS 1A), **George Anastassiou**, University of Memphis.

Fullerton, California

California State University, Fullerton

October 24–25, 2015
Saturday – Sunday

Meeting #1114
Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: August 2015
Program first available on AMS website: September 10, 2015
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: Volume 36, Issue 4

Deadlines
For organizers: March 27, 2015
For abstracts: September 1, 2015

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses
Mina Aganagic, University of California, Berkeley, *Title to be announced.*
John Lott, University of California, Berkeley, *Title to be announced.*
Eyal Lubetzky, Microsoft Research, Redmond, *Title to be announced.*
Zhiwei Yun, Stanford University, *Title to be announced.*

Special Sessions
If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at http://www.ams.org/cgi-bin/abstracts/abstract.pl.

Geometric Analysis (Code: SS 1A), **John Lott**, University of California, Berkeley, and **Aaron Naber**, Northwestern University.

New Brunswick, New Jersey

Rutgers University

November 14–15, 2015
Saturday – Sunday

Meeting #1115
Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: September 2015
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: November 2015
Issue of *Abstracts*: Volume 36, Issue 4

Deadlines
For organizers: April 14, 2015
For abstracts: September 22, 2015

Seattle, Washington

Washington State Convention Center and the Sheraton Seattle Hotel

January 6–9, 2016
Wednesday – Saturday
Joint Mathematics Meetings, including the 122nd Annual Meeting of the AMS, 99th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: October 2015

Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2016
Issue of *Abstracts*: Volume 37, Issue 1

Deadlines
For organizers: April 1, 2015
For abstracts: To be announced

Fargo, North Dakota

North Dakota State University

April 16–17, 2016
Saturday – Sunday
Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: To be announced
For abstracts: To be announced

Atlanta, Georgia

Hyatt Regency Atlanta and Marriott Atlanta Marquis

January 4–7, 2017
Wednesday – Saturday
Joint Mathematics Meetings, including the 123rd Annual Meeting of the AMS, 100th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic, with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: October 2016
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2017
Issue of *Abstracts*: Volume 38, Issue 1

Deadlines
For organizers: April 1, 2016
For abstracts: To be announced

Charleston, South Carolina

College of Charleston

March 10–12, 2017
Friday – Sunday
Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: November 10, 2016
For abstracts: To be announced

Pullman, Washington

Washington State University

April 22–23, 2017
Saturday – Sunday
Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: To be announced
For abstracts: To be announced

San Diego, California

San Diego Convention Center and San Diego Marriott Hotel and Marina

January 10–13, 2018
Wednesday – Saturday
Joint Mathematics Meetings, including the 124th Annual Meeting of the AMS, 101st Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: October 2017
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: April 1, 2017
For abstracts: To be announced

Meetings and Conferences of the AMS

Associate Secretaries of the AMS

Central Section: **Georgia Benkart**, University of Wisconsin-Madison, Department of Mathematics, 480 Lincoln Drive, Madison, WI 53706-1388; e-mail: benkart@math.wisc.edu; telephone: 608-263-4283.

Eastern Section: **Steven H. Weintraub**, Department of Mathematics, Lehigh University, Bethlehem, PA 18105-3174; e-mail: steve.weintraub@lehigh.edu; telephone: 610-758-3717.

Southeastern Section: **Brian D. Boe,** Department of Mathematics, University of Georgia, 220 D W Brooks Drive, Athens, GA 30602-7403, e-mail: brian@math.uga.edu; telephone: 706-542-2547.

Western Section: Michel L. Lapidus, Department of Mathematics, University of California, Surge Bldg., Riverside, CA 92521-0135; e-mail: lapidus@math.ucr.edu; telephone: 951-827-5910.

The Meetings and Conferences section of the *Notices* gives information on all AMS meetings and conferences approved by press time for this issue. Please refer to the page numbers cited in the table of contents on this page for more detailed information on each event. Invited Speakers and Special Sessions are listed as soon as they are approved by the cognizant program committee; the codes listed are needed for electronic abstract submission. For some meetings the list may be incomplete. **Information in this issue may be dated. Up-to-date meeting and conference information can be found at** www.ams.org/meetings/.

Meetings:

Important Information Regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 99 in the January 2014 issue of the *Notices* for general information regarding participation in AMS meetings and conferences.

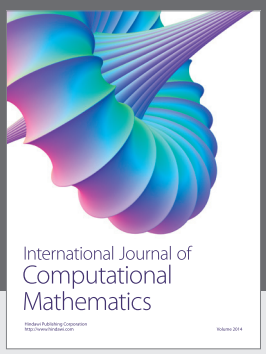
Abstracts

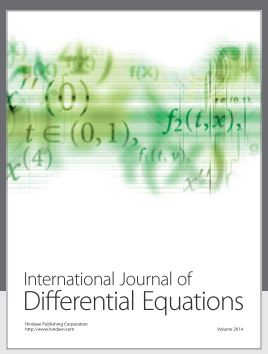
Speakers should submit abstracts on the easy-to-use interactive Web form. No knowledge of LaTeX is necessary to submit an electronic form, although those who use LaTeX may submit abstracts with such coding, and all math displays and similarly coded material (such as accent marks in text) must be typeset in LaTeX. Visit http://www.ams.org/cgi-bin/abstracts/abstract.pl. Questions about abstracts may be sent to abs-info@ams.org. Close attention should be paid to specified deadlines in this issue. Unfortunately, late abstracts cannot be accommodated.

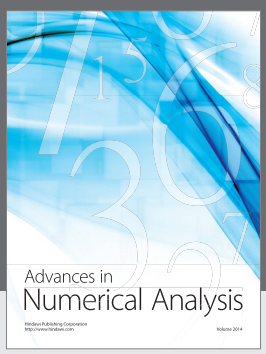
Conferences in Cooperation with the AMS: (see http://www.ams.org/meetings/ for the most up-to-date information on these conferences.)

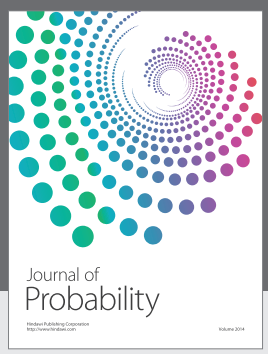
November 7–9, 2014: 7th International Conference on Science and Mathematics Education in Developing Countries, Mandalay University, Myanmar.

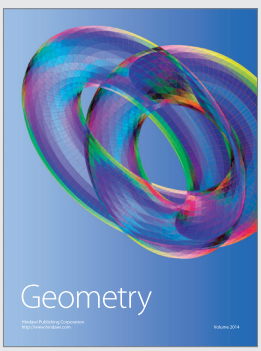
November 24–28, 2014: ICPAM-Goroka 2014: International Conference on Pure and Applied Mathematics, University of Goroka, Papua, New Guinea.

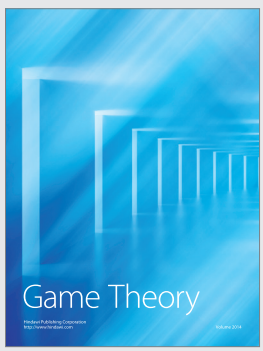


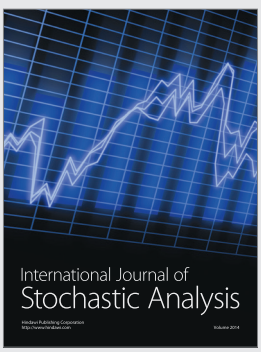


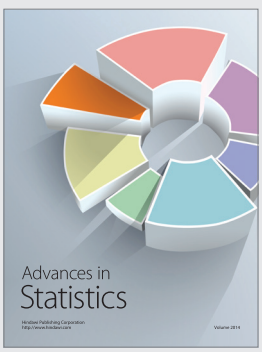


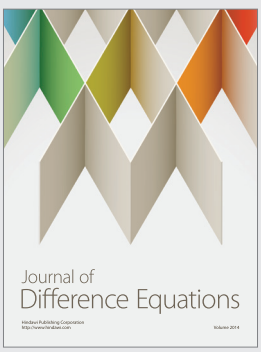


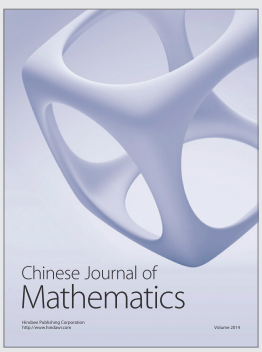


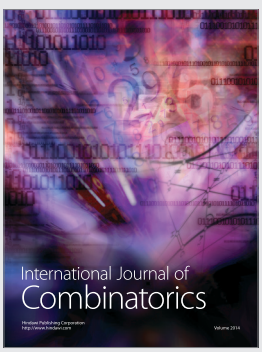


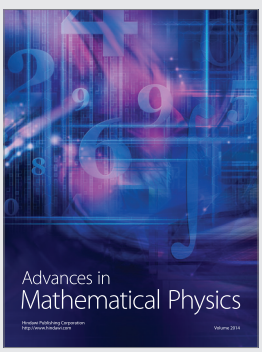


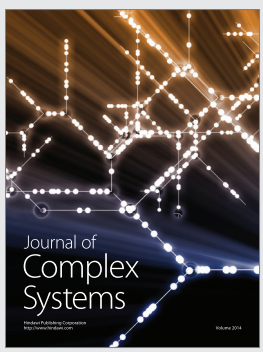












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