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# Notices

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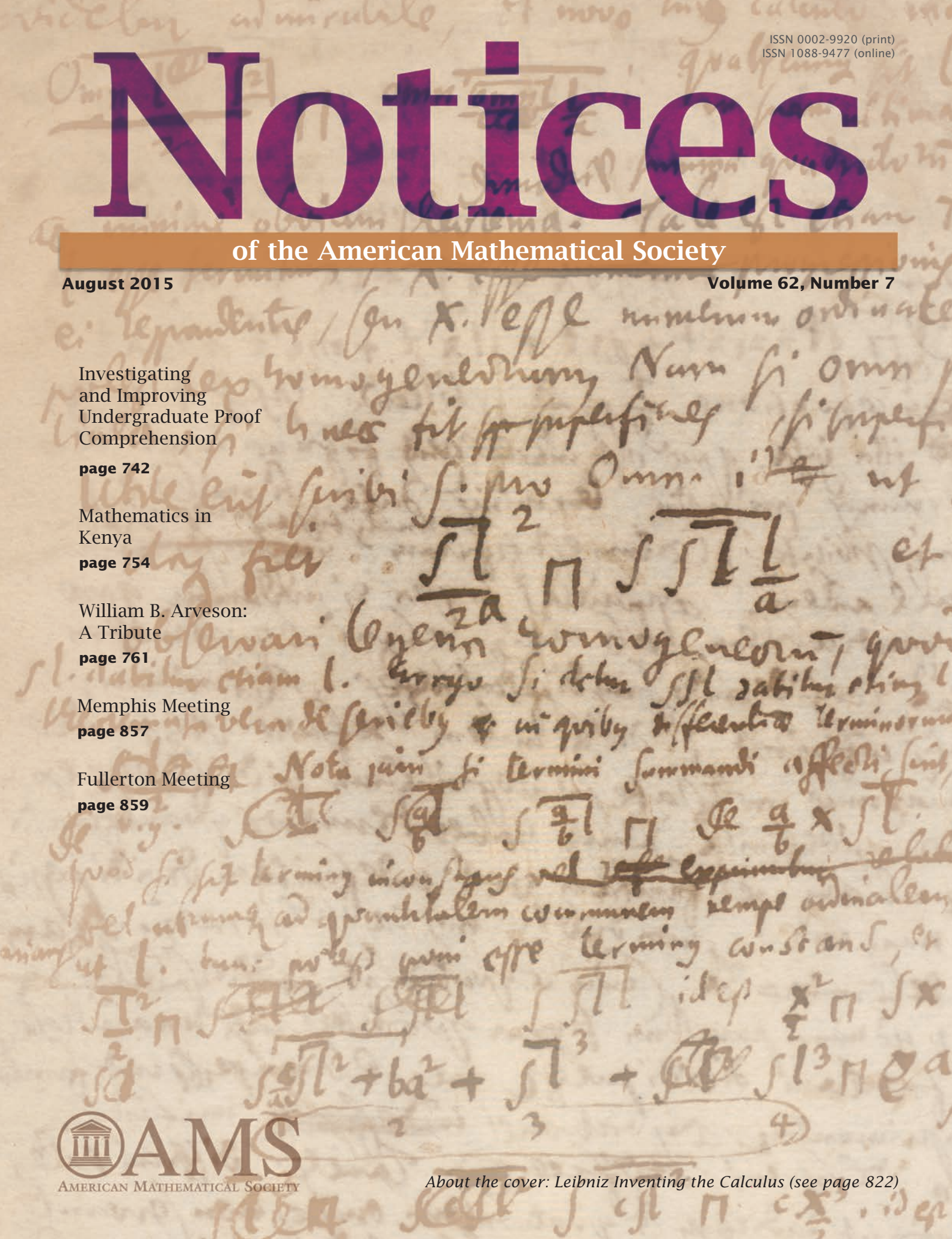

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# AMS Blogs

AMERICAN MATHEMATICAL SOCIETY

*interact + exchange + connect*

## Blog on Math Blogs

*Two mathematicians tour the mathematical blogosphere.* Editors **Brie Finegold** and **Evelyn Lamb**, both Ph.D. mathematicians, blog on blogs — on topics related to mathematics research, applied mathematics, mathematicians, math in the news, mathematics education, math and the arts and more.

blogs.ams.org/**blogonmathblogs**

## PhD + epsilon Blog

*An early-career mathematician blogs about her experiences and challenges.* **Adriana Salerno**, assistant professor at Bates College and 2007 AMS-AAAS Media Fellow, writes about her experiences and challenges as an early-career mathematician. All mathematicians are encouraged to join the community of her followers and post comments.

blogs.ams.org/**phdplus**

## e-Mentoring Network in the Mathematical Sciences

*Connecting students and mentors.* **Ricardo Cortez** (Tulane University) and **Dagan Karp** (Harvey Mudd College) as well as their invited contributors engage students and mentors —ask and answer questions, provide feedback, share links on meetings, networking and research opportunities, articles, non-academic career information, and other helpful resources.

blogs.ams.org/**mathmentoringnetwork**

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## AMS Graduate Student Blog

*A blog for and by math grad students.* **Tyler Clark** is editor-in-chief and **Frank Morgan** is publisher. Contributions, comments, and other involvement are welcome.

blogs.ams.org/**mathgradblog**

## Visual Insight: Mathematics Made Visible

*A place to share striking images that help explain advanced topics in mathematics.* Edited by **John Baez,** a professor of mathematics at U.C. Riverside.

blogs.ams.org/**visualinsight**

## On Teaching and Learning Mathematics

Editors **Benjamin Braun** and contributing editors **Priscilla Bremser**, **Art Duval**, **Elise Lockwood**, and **Diana White** stimulate reflection and dialogue by providing mathematicians with high-quality commentary and resources regarding teaching and learning. Topics include practical "teaching tips," commentary on current mathematics education research, discussions of social/curricular educational policy, and more.

blogs.ams.org/**matheducation**

## Joint Mathematics Meetings Blog

This blog is about the scientific program sessions, events, and other aspects of the annual Joint Mathematics Meetings of the AMS and MAA.

blogs.ams.org/**jmm2015**

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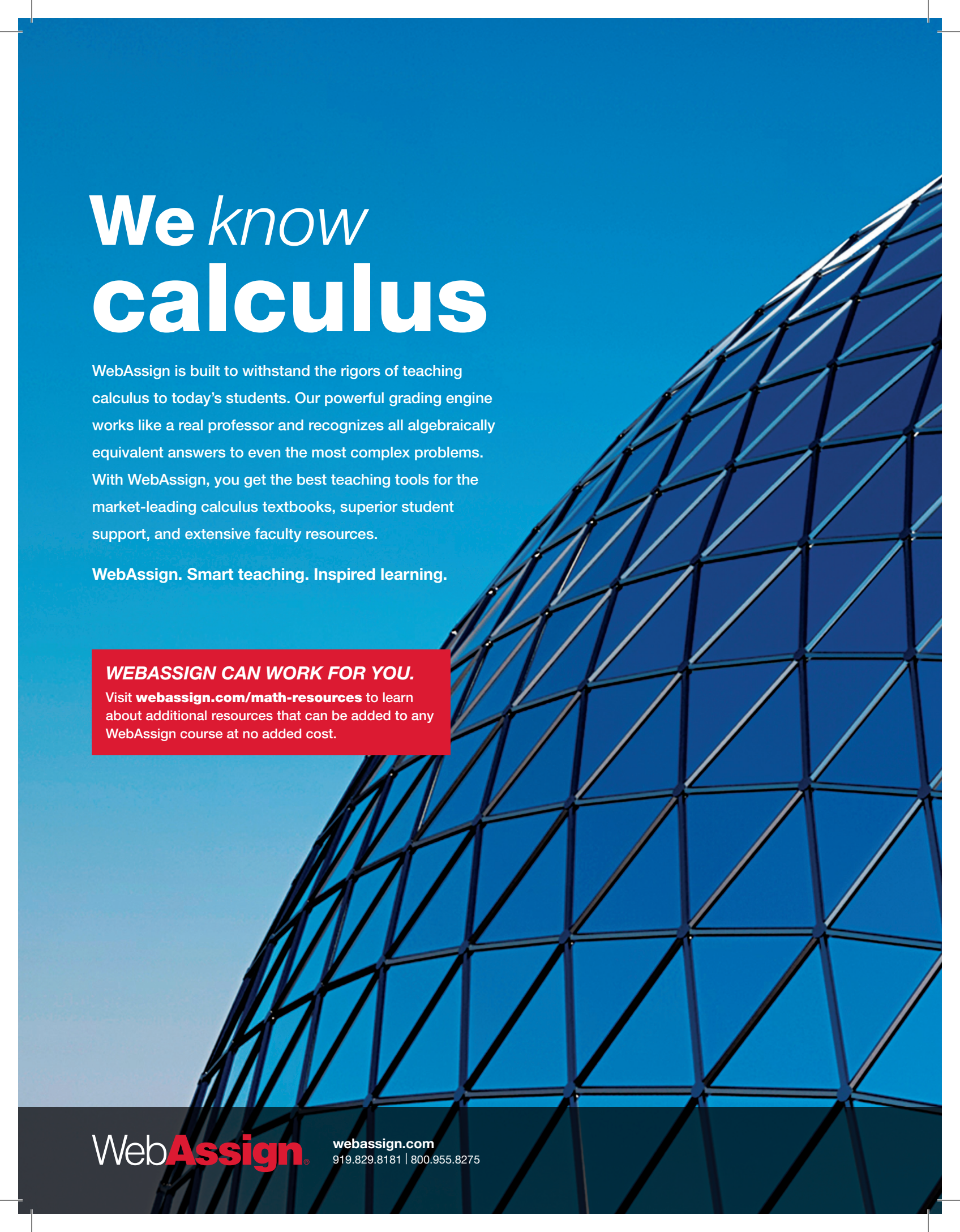

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There is a fascinating and visually stimulating article about improving undergraduate proof comprehension; an exciting look at the development of mathematics in Kenya based on Tom Denton's first-hand experience there; a memorial of complex analyst Al Baernstein II, and a tribute piece for analyst Bill Arveson.

*—Steven G. Krantz, Editor*

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# Notices

of the American Mathematical Society

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AMERICAN MATHEMATICAL SOCIETY

# Director of Education and Diversity

*Division of Meetings and Professional Services*

The American Mathematical Society (AMS) invites applications for the position of **Director of Education and Diversity**. This new position is focused on graduate education in the mathematical sciences, the preparation of students to enter graduate programs, mentoring of students for success in graduate school, and the promotion of diversity and inclusiveness at the graduate level.

**About the AMS:** The AMS, founded in 1888 to further the interests of mathematical research and scholarship, serves the national and international community through its publications, meetings, advocacy and other programs supporting professionals in the mathematical sciences. The Society supports mathematical education at all levels and advances the status of the profession of mathematics, encouraging and facilitating full participation of all individuals.

**Responsibilities:** The Director of Education and Diversity provides leadership for the Society's programs supporting education. Primary goals for the position are to improve the students' preparation and success rate in graduate programs leading to an advanced degree in the mathematical sciences, especially for those from underrepresented groups, including women. The director is expected to work closely with the AMS Committee on Education, with AMS membership and professional program activities, and with academic departments at the undergraduate and graduate levels toward these goals. The responsibilities include identifying opportunities for external funding and overseeing the preparation of funding proposals to achieve these goals.

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This is a full-time position at the AMS headquarters in Providence, with a starting date of January 1, 2016. Salary will be commensurate with experience.

**Applications:** Applications must include a curriculum vitae and a letter describing the applicant's administrative and academic experience and his or her interest in the position. Applications received by August 20 will receive full consideration. Nominations and applications should be sent to:

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# Investigating and Improving Undergraduate Proof Comprehension

*Lara Alcock, Mark Hodds, Somali Roy, and Matthew Inglis*

Undergraduate mathematics students see a lot of written proofs. But how much do they learn from them? Perhaps not as much as we would like; every professor knows that students struggle to make sense of the proofs presented in lectures and textbooks. Of course, written proofs are only one resource for learning; students also attend lectures and work independently or with support on problems. But because mathematics majors are expected to learn much of their mathematics by studying proofs, it is important that we understand how to support them in reading and understanding mathematical arguments.

This observation was the starting point for the research reported in this article. Our work uses psychological research methods to generate and analyze empirical evidence on mathematical thinking, in this case via experimental studies of teaching interventions and quantitative analyses of eye-movement data. What follows is a chronological account of three stages in our attempts to better understand students' mathematical reading processes and to support students in learning to read effectively.

In the first stage, we designed resources we called *e-Proofs* to support students in understanding specific written proofs. These e-Proofs conformed to typical guidelines for multimedia learning resources, and students experienced them as useful. But a more rigorous test of their efficacy revealed that students who studied an e-Proof did not learn more than students who had simply studied a printed proof and in fact retained their knowledge less well. This led us to suspect that e-Proofs made learning feel easier, but as a consequence resulted in shallower engagement and therefore poorer learning.

At the second stage we sought insight into possible underlying reasons for this effect by using eye-movement data to study the mechanisms of mathematical reading. We asked undergraduate students and mathematicians to read purported proofs and found that experts paid more attention to the words and made significantly more back-and-forth eye movements of a type consistent with attempts to infer possible justifications for mathematical claims. This result is in line with the idea that mathematical experts make active efforts to identify logical relationships within a proof and that effective guidance might therefore be needed to teach students to do the same thing.

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*Somali Roy recently completed her PhD at the Mathematics Education Centre at Loughborough University with a thesis entitled "Evaluating a novel pedagogy in higher education: A case study of e-Proofs." Her email address is* S.roy@lboro.ac.uk.

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*The present article draws on work supported by the Royal Society and by the Higher Education Academy's Maths, Stats & OR Network. Self-Explanation Training for Mathematics Students is available at* www.setmath.lboro.ac.uk.

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Finally, at the third stage, we produced such guidance by adapting *self-explanation training* to form a simple, generic guide to studying mathematical proofs. In a series of three studies we found that students who studied the training gave higher-quality mathematical explanations, exhibited altered eye movements that were more like those of expert mathematicians, and performed significantly better in both immediate and delayed proof comprehension tests. In the remainder of this article we explain this work in detail, giving rationales for our empirical study designs, explaining the nature of the self-explanation training, and expanding the arguments outlined here.

## e-Proofs

We began by considering the challenges students face when learning from proofs presented in lectures. One problem, as we saw it, was that live explanations given in lectures are potentially ambiguous and certainly ephemeral: gestures indicating where attention should be focused can be vague, and the professor's additional explanations often go unrecorded so they are no longer available when students engage in independent study of their notes or a textbook. We set out to remedy this by taking advantage of straightforward presentation technology, constructing e-Proofs for several of the more difficult theorems in a course on real analysis (the course covered typical early material on continuity, differentiability, and integrability, with epsilon-delta definitions). Each e-Proof showed a theorem and a complete accompanying proof and was split into 8–10 screens. Each screen (see Figure 1 for an example) focused attention on particular aspects of the proof by graying out some areas and indicating links with boxes and arrows; each had a short accompanying audio file that could be played with a click. Students could navigate freely through the screens, listening to the audio and watching the animations as many or as few times as they wished (for detail see [1]).

Our e-Proofs were designed to capture the additional explanations that a professor might give in a lecture and to improve upon them by ensuring that students' attention was appropriately focused. The design features of e-Proofs meant that they conformed to guidelines typically offered as a consequence of research on multimedia educational resources: they moved some essential processing from visual to auditory channels, they allowed time between successive bite-sized segments, they provided cues to reduce processing of extraneous material, they avoided presenting identical streams of printed and spoken words, and they presented narration and corresponding animation simultaneously to minimize the need to hold representations in memory (cf. [2]). The provision of e-Proofs was popular with students, who saw them as a useful supplement to lectures. Free-form feedback on the course as a whole evoked numerous remarks of the type that are encouraging for educational innovators:

> *I found hearing the lecturer explaining each line individually helpful in understanding particular parts and how they relate to the entire proof.*

> *Having proofs online does make it easier to go at my own pace while still having the lecturer explain each part.*

Unfortunately, it turned out that our e-Proofs did not have the desired effects in terms of improved understanding and learning. We discovered this by conducting an experimental study in which students studied a new theorem (Cauchy's general-

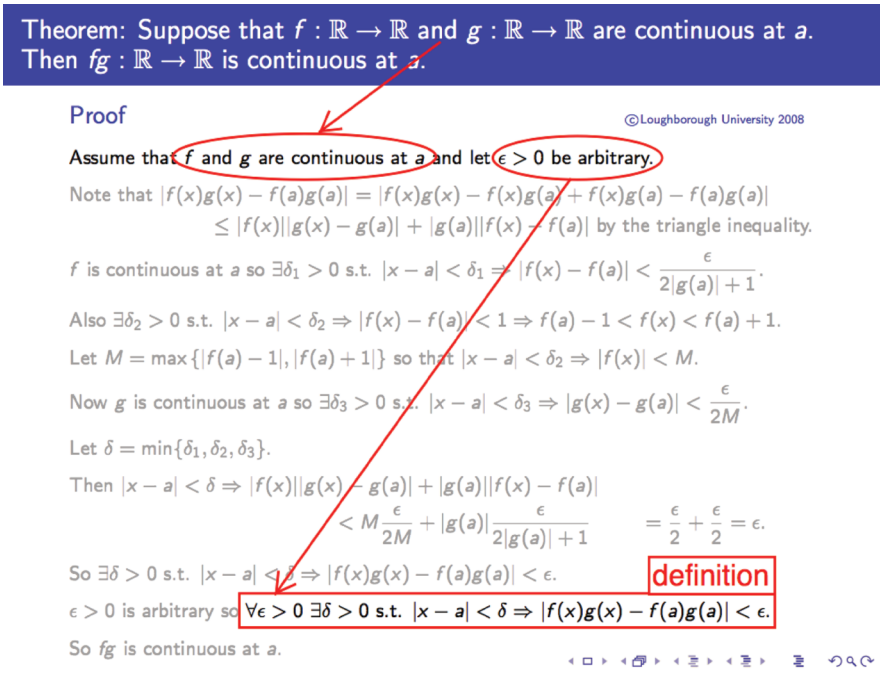


**Figure 1. A typical e-Proof screen. The accompanying audio said, "In the first line, we state our assumption that $f$ and $g$ are continuous at $a$, which corresponds to the premise of our theorem. We also let epsilon greater than zero be arbitrary, because we want to show that $fg$ satisfies the definition of continuity at $a$, which we will achieve by the end of the proof. Doing so involves showing that something is true for all epsilon greater than zero, so choosing an arbitrary epsilon means that all our reasoning from now on will apply to any appropriate value."**

ized mean value theorem) and an accompanying proof. The students were randomly assigned to either an experimental group who studied an e-Proof or a control group who studied the same theorem and proof on paper for the same fixed amount of time. All students then took a comprehension test designed according to the principles outlined in [3]: there were questions testing basic knowledge of algebra and differentiation, understanding of the logical reasoning used in the proof, application of ideas in the proof to examples, and ability to summarize the argument. This immediate post-test was followed two weeks later by an identical delayed post-test that was not announced in advance. The results appear in Figure 2.

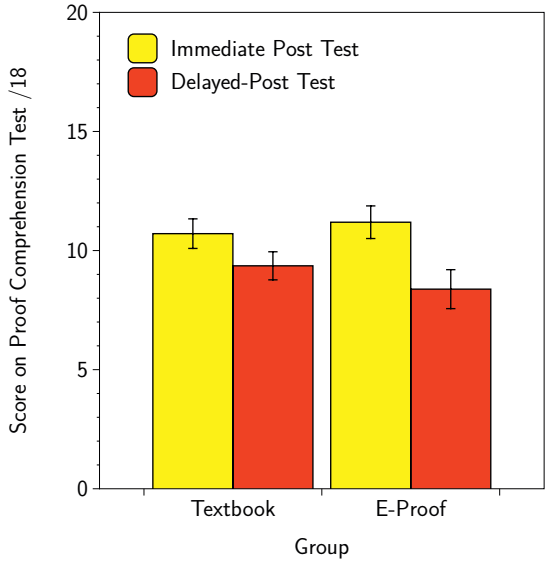


**Figure 2. Mean scores for the e-Proof group and the standard presentation group. Error bars show ±1 standard error of the mean. An analysis of variance (ANOVA) revealed a significant main effect of time, $F(1, 47) = 28.213$, $p < .001$, and a significant × time group interaction effect, $F(1, 47) = 5.659$, $p = .021$.**

The average scores of the experimental and control groups were not significantly different either at immediate post-test or at delayed post-test. But there was a significant interaction effect: the performance of the students in the e-Proof group dropped more in the intervening time (for details see [4]).

This was a humbling reminder that good pedagogical intentions do not always translate into effective interventions. It does not mean that resources like e-Proofs are never valuable—it could be, for example, that they are not good for first-time learners but are valuable resources for students who have already studied a proof independently and would benefit from clarification on aspects that they have found confusing or difficult. Nevertheless, this result presented a salutary lesson on the limitations of our own understanding of the process of learning from mathematical text: it was clear that we should not construct more e-Proofs or recommend their wider use until we knew more about students' reading processes.

The outcome also raised the broader concern that students might not be accurate reporters on the quality of their own learning. In this case, it seemed likely that students using e-Proofs felt good about their learning because they were able to understand without too much effort, but that this very fact meant that the understanding they acquired was less robust in the longer term. This explanation has been largely confirmed in further studies by the third author—for details see [5]—and is also supported by the remainder of the work presented in this article.

## Eye Movements during Mathematical Reading

Our next move was to take a step back and begin a more basic investigation of mathematical reading, studying this process by comparing experts' and novices' eye movements. Eye movements can be studied using technology that allows the researcher to track an individual's focus of attention as that person views information presented on a screen. Modern remote eye-trackers monitor the viewer's pupils using infrared cameras, which are not invasive. Before recording, the tracker must be calibrated by asking the viewer to follow a dot around the screen with their eyes, but the viewer feels nothing, and after calibration the screen looks and behaves exactly like that of an ordinary computer. Eye-tracking is used widely in research on reading (e.g. [6]), and the empirically established close link between fixation location and attention location [7] means that it provides a useful window into the processes involved in reading a text.

Specifically, eye movements lend themselves to quantitative analyses because, although readers experience smooth movement as their eyes shift around a screen, eye movements in fact consist of short *fixations*—typically of around 150–500 milliseconds (ms)—interspersed by very rapid moves known as *saccades* (e.g. [8]). Figure 3 shows a scan path tracing one participant's reading of the instructions for our experiment.

To investigate mathematical reading processes we recruited groups of experts (mathematicians) and novices (first-year undergraduate mathematics students in the UK, roughly the equivalent of US sophomore mathematics majors in terms of mathematical experience). Participants were invited individually to visit our eye-movement lab and were asked to view several purported proofs. For each proof, they were asked to click buttons on a subsequent screen to indicate whether they believed the proof to be valid and how confident they were about their judgment. The first four purported proofs were very short arguments in

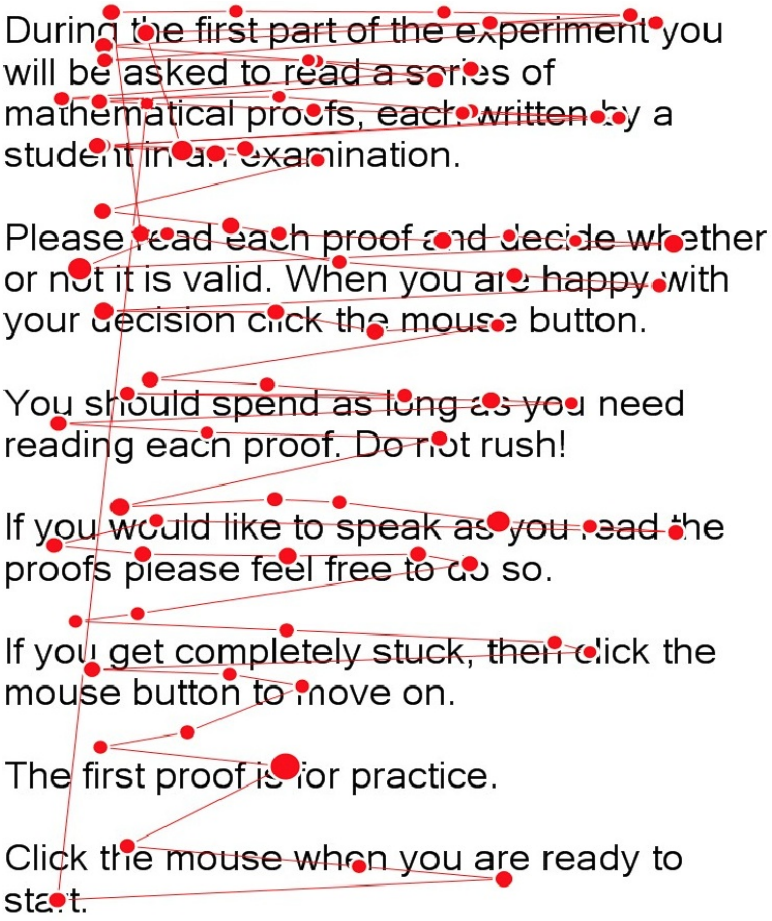


**Figure 3. A scan path tracing one participant's eye movements while reading the instructions for the experiment. The discs indicate fixation locations and the straight lines indicate saccades between those locations (these images are produced postrecording by the eye-tracking software and are not visible to the viewer).**

elementary number theory that were presented as having been produced by students; the last two were longer and were presented as having been submitted to a recreational mathematics journal (for details see [9]).

We analyzed the eye-movement data in several stages. First, we looked at attention to different features of the proofs. Previous research based on interview studies had led to suggestions that students made poor judgments about proof validity because they tended to focus on the "surface features" of proofs; that they attended adequately to algebraic manipulations but not to the logical structure of an argument as a whole [10]. Our eye-movement data suggested that this might indeed be the case.

Figure 4 (next page) shows one of the longer purported proofs, together with heat maps indicating the degree of attention to different parts of this purported proof by the novices (bottom) and the experts. There is an immediately apparent difference in that the expert mathematicians were very interested in the fifth line of the argument. The validity of the proof depends upon the claim in this line, but the claim is invalid in general and there is no information elsewhere that would make it valid in this context by restricting its applicability. More subtly, the differences do suggest that the students attended more to the algebraic notation.

**Figure 4. Heat maps showing attention to different parts of an invalid purported proof by mathematicians (top) and undergraduates (bottom) based on data averaged across all participants.**

Statistical analyses confirmed this observation. For all six of the purported proofs, we calculated the participants' total *dwell times* on the formulae and on the remaining text (dwell time is calculated by adding the durations of all the individual fixations in a given area of interest; formulae were identified as those parts typeset with math mode in LaTeX). As can be seen in Figure 5, the mean dwell times of the experts and the novices differed: the groups spent about the same amount of time looking at the formulae, but the mathematicians spent more time looking at the words. This provides a measure of empirical support for what many mathematicians suspect: that students at the transition-to-proof level are attentive to algebra but are comparatively unlikely to notice invalid logical reasoning as captured in words.

Next, we looked at another global feature of reading behavior: the pattern of saccades

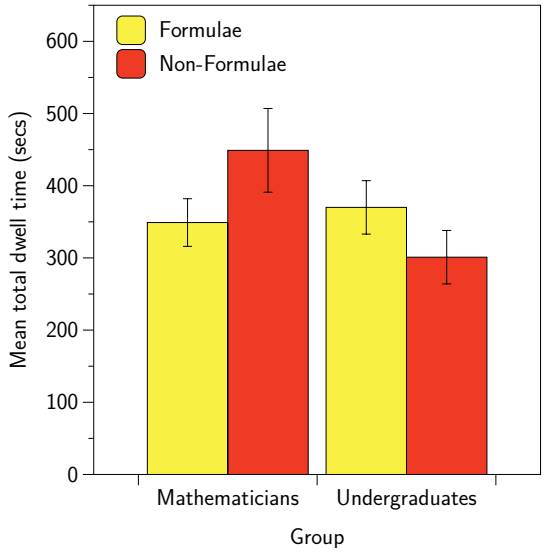


**Figure 5. Mean total dwell times on formulae and nonformulae for mathematicians and undergraduates. Error bars show ±1 standard error of the mean. An ANOVA revealed a significant type × status interaction: $F(1, 28) = 8.81$, $p = .006$, $\eta_p^2 = .239$; the students spent proportionately longer fixating on the formulae than did the mathematicians.**

around the screen as the reader worked to understand the proof. This required some analytical decisions because it is not practical to describe and meaningfully compare single reading attempts: a five-minute attempt could involve over 1,000 fixations, so general patterns are easily swamped by the detail. We proceeded, therefore, by considering prior theoretical analyses of arguments in general and mathematical arguments in particular.

To a first approximation, a proof can be considered as a sequence of deductions in which each line should follow logically from theorem premises, previous lines, and agreed definitions and theorems (a specific proof might, of course, have a structure more complex than this). In principle it could be that for each deduction there is an explicitly stated *warrant*, a justification for the new claim [11]. In practice, however, many warrants will be left implicit: the author of a proof will expect readers to be able to infer warrants considered to be either common knowledge (in the appropriate context) or otherwise sufficiently obvious from the written material. A reader engaged in a serious attempt to understand a proof therefore has to decide whether a new line requires a warrant and to identify whether and where information relevant to a possible warrant appears elsewhere in the theorem or proof. If individuals do this, we would expect to see it reflected in their eye movements: saccades should take them back and forth between the various lines of the proof.

To obtain a simple measure of this type of behavior, we counted saccades of two types: *within-line saccades* that began and ended within the same line of a proof and *between-line saccades* that began and ended in different lines of the proof (there were of course saccades that began or ended in white space or off the screen; these were not included in our analysis). We found that experts and novices read differently: the experts made significantly more between-line saccades,[1] which is consistent with a search for logical relationships among the lines of the proofs. Figure 6 (next page) illustrates this by showing a scan path of one mathematician's reading of one of the longer purported proofs. Comparing this with the same mathematician's reading of our instructions in Figure 3 highlights an important difference: there is much more back-and-forth movement than one typically sees in ordinary reading.

This result is particularly notable given the mathematical content of the proofs. This content was very straightforward for the mathematicians, necessarily so because our experimental design required the material to be accessible to undergraduates. As a result, one would expect the mathematicians' reading behavior to involve less checking back and forth than would be necessary for the novices. The fact that the experts instead exhibited *more* of this behavior strongly suggests that this is an important feature of expert mathematical reading and one that needs to be developed by typical undergraduates.

Eye-movement data is a rich source of information, and, combined with our other data, it also allowed us to conduct further analyses. Using the validity judgments, we confirmed that undergraduates did not perform well in distinguishing valid from invalid proofs. But we also found that mathematicians did not agree nearly as much as might be expected about the validity of even simple arguments; we have since followed up on this result with a larger study reported in [12].

[1] *78.8 between-line saccades per proof compared with 53.3 per proof, t(28)=2.11, p=.044, d=0.80.*

Using the eye-movement data, we discovered that mathematicians did not conduct initial "skim reads" of the purported proofs, despite routine self-report-based claims that this is a common behavior (e.g. [13]); these results are reported in [9] and [14]. Finally, we examined eye-movement sequences that we considered particularly likely to indicate searches for implicit warrants: shifts from one line of a proof to its predecessor and back again. We found (see [9]) that mathematicians were three times more likely than undergraduates to make such eye movements but that both mathematicians and students were significantly more likely to behave in this way when a warrant was required (when a line required justification rather than simply, say, introducing new terminology). For the purposes of our work on proof comprehension, this indicated a possible way forward.

## Self-Explanation Training in Mathematics

We reasoned that if students were aware that they should be looking for justifications but were not doing so very much or very effectively, their comprehension could perhaps be improved via simple training encouraging them to devote more effort to this aspect of mathematical reading. The training approach we took was based on the literature on reading to learn and specifically on a promising intervention commonly termed *self-explanation training*. Self-explanation training is based on early observations, that when learning from texts on Newtonian mechanics, students who showed better subsequent problem-solving performance made more self-explanations: they were more inclined to articulate interpretations that involved information and relationships beyond those explicitly contained in the text [15]. There is a large and growing literature on self-explanation effects (e.g. [16]), and variants on self-explanation training have been used with lower-level mathematics students [17]. But such training had not been adapted for use in undergraduate mathematics.

We adapted a version of self-explanation training from earlier materials used in [18] and [19]. Our training was presented in a series of computer slides for studies conducted in the lab and in a paper booklet for studies conducted in a lecture theatre. The slides and booklet elucidated key principles of self-explanation training as applied to mathematical proofs. Specifically, they:

- instructed students to identify key ideas in each line of a proof and to explain each line in terms of other ideas in the text or in terms of their own existing knowledge;
- noted that self-explanation differs from simply paraphrasing the text without adding new information and from making monitoring statements such as "Okay, I understand that line";
- demonstrated the self-explanation strategy by exhibiting possible student self-explanations in relation to a very short example proof;
- instructed students to generate self-explanations in response to a practice proof.

A full version of the self-explanation training is available at `www.setmath.lboro.ac.uk`; students in our studies spent approximately 15–20 minutes working through it.

Our first study was conducted in the lab. Student participants attended an individual session and were randomly assigned to either an experimental or a control group. Those in the experimental group studied the self-explanation training, and to equalize the time spent in the lab environment, those in the control group were

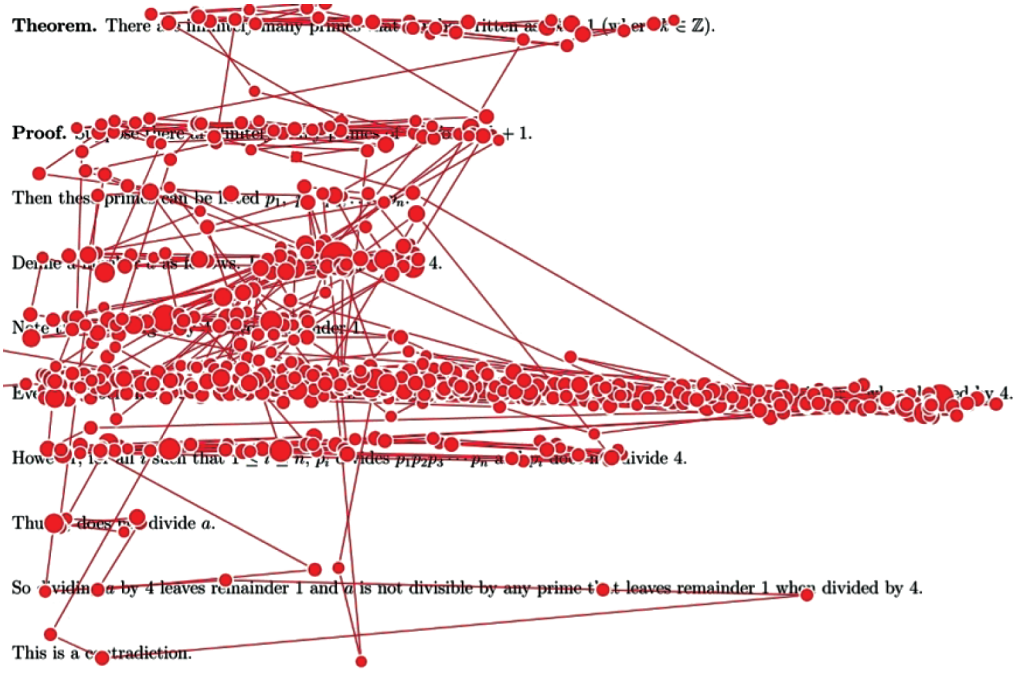


**Figure 6. A scan path tracing one mathematician's eye movements as he/she reads an invalid purported proof. Compared with the scan path in Figure 3, this shows more back-and-forth movement during the reading attempt.**

asked to read and answer questions on a passage on the history of mathematics. Participants in both groups were then asked to read a proof presented on a screen, first silently and then taking one line at a time and giving explanations out loud. The only difference in this stage was that the self-explanation group was explicitly asked to use its training as a guide when generating these explanations. Finally, each participant completed a fourteen-item free-response proof comprehension test designed according to the principles outlined in [20]. This study design provided us with two sets of data: the participants' verbal explanations and their proof comprehension scores.

Analyses revealed that the self-explanation training had the desired effect. The participants' verbal explanations were classified using a scheme adapted from [19], and we found that students in the self-explanation group gave significantly more high-quality explanations: they produced around twice as many explanations that were classified as *inferring warrants* (articulating justifications), *noticing coherence* (relating lines of a proof to each other), or *being goal driven* (relating a line to the overall goal of proving the theorem). The full range of classification types and numbers is captured in Figure 7.

The comprehension test data required a more nuanced analysis, because time spent studying the proof was correlated with comprehension score and because those in the self-explanation group spent longer on average studying the proof. We were not interested simply in increasing study time; we wanted to know whether students in the self-explanation group learned more effectively. We thus controlled for study time and found that the scores of students in the self-explanation group were significantly higher. Moreover, the size of the effect was large: the students who had received the self-explanation training scored on average almost one standard deviation higher than those in the control group. Finally, we found that this effect was evident across students from all three of the university's academic years, as shown in Figure 8.

Encouraged by this experimental result, we went on to further study its causes by extending our eye-movement work. In particular, we were interested in whether self-explanation training led to observable changes in reading behavior. This required a somewhat complex study design because, as might be anticipated, there is considerable individual variation in eye movements.

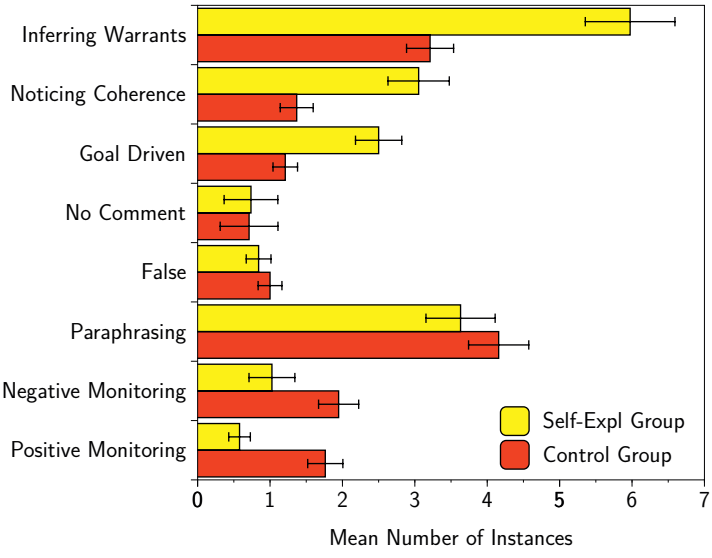


**Figure 7. Mean numbers of explanations of different types given by students in the self-explanation training and control groups. Error bars show ±1 standard error of the mean. Bonferroni-corrected Mann Whitney $U$ tests revealed significant differences in numbers of comments classified as principle-based, $U = 386$, $p < .001$, noticing coherence, $U = 399$, $p = .001$, or goal-driven, $U = 407$, $p = .001$ (and as positive monitoring, $U = 400$, $p < .001$ and negative monitoring, $U = 440$, $p = .002$).**

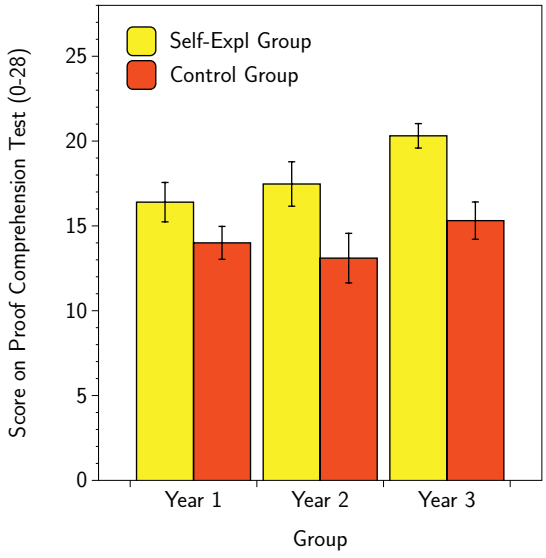


**Figure 8. Mean scores on the proof comprehension test, separated by condition and year of study. Error bars show ±1 standard error of the mean. A 3 (year) × 2 (condition) analysis with covariance (ANCOVA) with time as a covariate revealed a main effect of condition, $F(1, 69) = 181.459$, $p < .001$, with those in the self-explanation group outperforming those in the control group. It also revealed a main effect of year, $F(2, 69) = 3.456$, p = .037, with those in Year 3 ($M = 17.8$, $SD = 4.2$) outperforming those in Years 2 ($M = 15.8$, $SD = 5.2$) and 1 ($M = 14.9$, $SD = 3.9$), but no significant year × condition interaction, $p > .2$.**

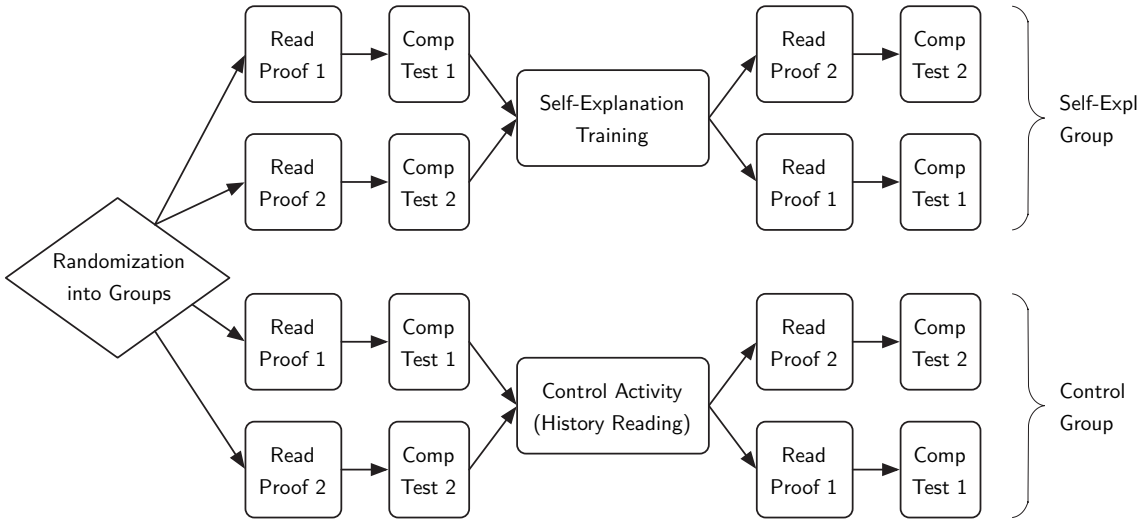


**Figure 9. Design for the study of the effects of self-explanation training on eye movements ([22], p. 74).**

The design involved four groups and is represented diagrammatically in Figure 9. In this within-subjects design, every participant studied two proofs and completed two proof comprehension tests (multiple-choice tests in this case). This allowed us to study changes in individual reading behavior. The experimental groups received the self-explanation training and the control groups read the alternative text as before, and we were interested in comparing the groups' reading behaviors and comprehension scores for the second proof they read. But it is also conceivable that differences between two proofs would generate systematic differences in reading behaviors and scores, so both the experimental and the control groups were split into two and a counterbalanced design was employed in which half saw one proof first and half saw the other.

Analyzing the comprehension scores again showed that self-explanation training had a positive effect. Independently of which proof was seen second and controlling for comprehension scores on the first attempt, the self-explanation groups outperformed the control groups.[2]

Of more interest in this case, however, was the change in reading behaviors. We investigated these using two separate measures. First, we looked at mean fixation duration, which acts as a measure of intellectual effort: higher mean fixation durations reflect harder concentration (e.g. [21]). We compared the mean fixation durations of students in the experimental and control groups on whichever proof they read second, this time controlling for mean fixation durations on proof read first to account for preexisting individual differences on this measure. This analysis revealed a between-groups difference: regardless of the order in which the participants experienced the proofs, those who received the self-explanation training subsequently concentrated harder.[3]

Second, we looked as before at between-line saccades (see Figure 10). We compared the numbers of between-line saccades for students in the experimental and control groups on the proofs they read second, this time controlling for both the time taken to read this proof (we were effectively interested in between-line saccades per minute, not total saccades) and the number of between-line saccades for the proof read first (again to account for individual differences in reading behavior). This time we found a main effect of proof: some proofs, it seems, do prompt different reading behaviors. For the self-explanation training, we again found a significant difference in the expected direction: regardless of the order in which they experienced the proofs, students who had received the training subsequently made significantly more between-line saccades. This indicates more shifts of attention around the proof and is consistent with more attention to logical relationships between the lines of the proof. In other words, students who had received self-explanation training exhibited reading behaviors more like those associated with expert mathematical reading.

[2] *An ANCOVA with two between-subjects factors (condition: self-explanation, control; proof read second: Proof 1, Proof 2) and one covariate (proof comprehension scores from the first reading attempt) showed a main effect of condition, $F(1,27) = 8.850$, $p = .006$, $\eta_p^2 = 0.247$, but no significant effect of proof order and no significant condition-by-proof-order interaction, both $Fs < 1$.*

[3] *An ANCOVA with two between-subjects factors (condition: self-explanation training, control; proof read second: Proof 1, Proof 2) and one covariate (mean fixation durations for the proofs read first) revealed a significant main effect of condition, $F(1,23) = 14.234$, $p = .001$, $\eta_p^2 = .382$ but no significant main effect of proof order and no significant condition-by-proof-order interaction, $ps > .3$.*

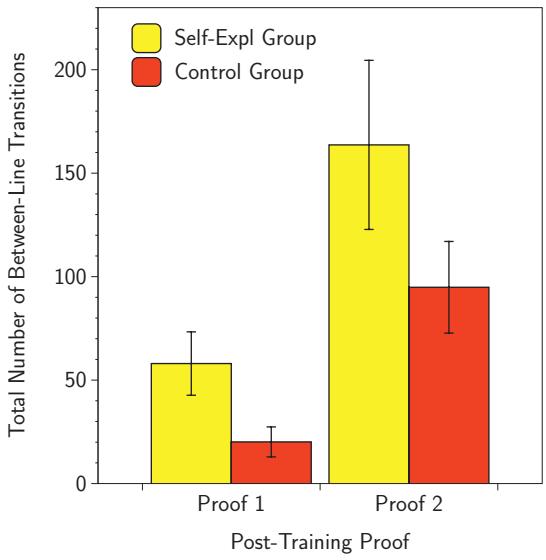


**Figure 10. Mean numbers of between-line saccades for the proof read second, split by condition and proof read second. Error bars show ±1 standard error of the mean. An ANCOVA with two between-subjects factors (condition: self-explanation training, control; proof read second: Proof 1, Proof 2) and two covariates (number of between-line saccades made during the first proof reading attempt and the overall duration of the second proof reading attempt) revealed a significant effect of condition, $F(1,22) = 10.394$, $p = .004$, $\eta_p^2 = 0.321$, and a significant effect of proof order, $F(1,22) = 8.449$, $p = .008$, $\eta_p^2 = 0.277$, but no significant interaction between condition and proof order, $p = .742$.**

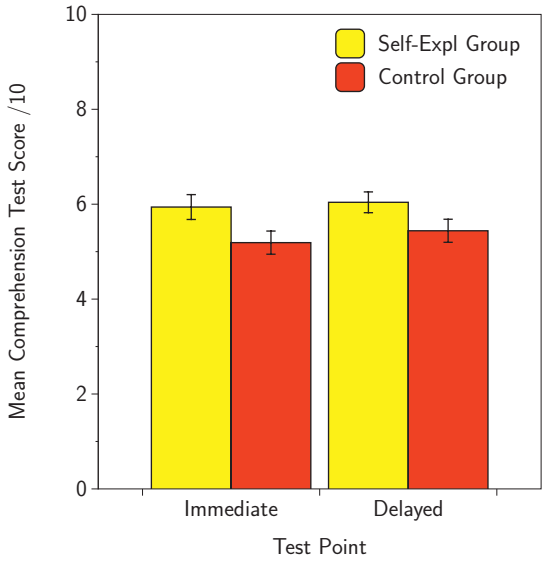


**Figure 11. Mean scores at post-test and delayed post-test, split by condition and time. Error bars show ±1 standard error of the mean. An ANOVA with one within-subjects factor (time: immediate post-test, delayed post-test) and one between-subjects factor (condition: self-explanation, control) showed a main effect of condition, $F(1,105) = 6.024$, $p = .016$, $\eta_p^2 = 0.054$, but no significant effect of time and no interaction between condition and time, $F < 1$ in both cases. The differences corresponded to effect sizes of $d = 0.410$ at post-test and $d = 0.350$ at delayed post-test.**

Finally, we took our work out of the lab and into the classroom, conducting a larger-scale study of the effects of self-explanation training for students working individually in an ordinary lecture theater. One hundred seven first-year calculus[4] students were randomly assigned to experimental and control groups, where in this case the self-explanation group read a printed version of the self-explanation training and the control group read materials on time management for mathematics students. All students then read a proof and took a multiple-choice comprehension test. In this case, we also followed up twenty days later with a delayed post-test in which all students were asked to read a second proof and take a second multiple-choice comprehension test. The results are shown in Figure 11; they indicated that in both immediate and delayed post-tests, scores of students in the self-explanation group were significantly higher.

Detail on all three of our self-explanation studies can be found in [22].

## Discussion

The research reported here has given us improved insight into mathematical reading and expertise, and into the effects of specific research-based teaching interventions. And it leads to a simple implication: undergraduate mathematics students should receive self-explanation training because this can be expected to improve their mathematical reading and consequently their proof comprehension.

However, as is always the case with empirical research, our work has limitations and opens up more questions than it answers. It would be a mistake, for instance, to infer that self-explanation training constitutes a silver bullet: the proofs used in our studies were all fairly short ones drawn from number theory, the experimental groups did not end up with perfect understanding, and certainly there is room for more nuanced research to investigate interactions between self-explanation training and factors like mathematical topic, students' prior knowledge, and alternative pedagogical strategies. It is possible, for instance, that self-explanation effects would be more pronounced for certain groups of students, that the training might be ineffectual for some groups or for some mathematical topics, or that the effects

[4] *In the UK students specialize earlier than they do in US-style systems. Participants in this study had worked on single-variable calculus as part of A-Level Mathematics between the ages of sixteen and eighteen and were taking a course that reviewed this material and extended it into multivariable calculus.*

could be enhanced by opportunities to practice self-explanation strategies in the classroom or by combination with other learning experiences. One important message in this regard is that at this stage we do not know—empirical research is required to investigate these possibilities.

We believe that this message is particularly important in the contemporary educational environment in which much is made of the potential of technology to enhance learning and much value is placed upon innovation. Much less value typically is placed on evaluation, and we think that this is a mistake. The world of the contemporary student is full of apparently useful resources, and access to these is becoming ever easier. This might be good, and it is certainly empowering: students can take charge of their own learning, locating and using resources that provide them with what they feel they need. But many resources are expensive to produce; developing them requires a substantial investment of academic time and technical support. And not all resources will lead to improved learning. As we discovered in our work with e-Proofs, interventions that are designed to make things easier might succeed in that aim and might be well received, but this does not guarantee that they provide effective support for sustainable learning. This, we believe, will always make it risky to evaluate innovations using only self-reporting measures: students might sincerely believe that new resources are of benefit, and they might be right in the sense that those resources make learning easier in the short term, but our results collectively suggest that it might be preferable to leave some resources as they are and focus instead on helping students to engage with them effectively. Perhaps some things should be difficult.

With these comments in mind, we believe that the success of self-explanation training across our three studies is encouraging not only because it appears to be effective but also for two further reasons. First, self-explanation training is extremely light touch: it is generic, it does not rely upon time-intensive adaptation of existing resources, and students can work through it independently in about 15–20 minutes (as noted above, the training is available at `www.setmath.lboro.ac.uk` for readers who might wish to use it). Second, self-explanation training does not require more work from the student; it encourages more effective independent work by simply teaching students to make better use of their existing knowledge and reasoning skills. Studies in education research often highlight what students cannot do, so it is cheering to be able to present positive results based on things that they can.

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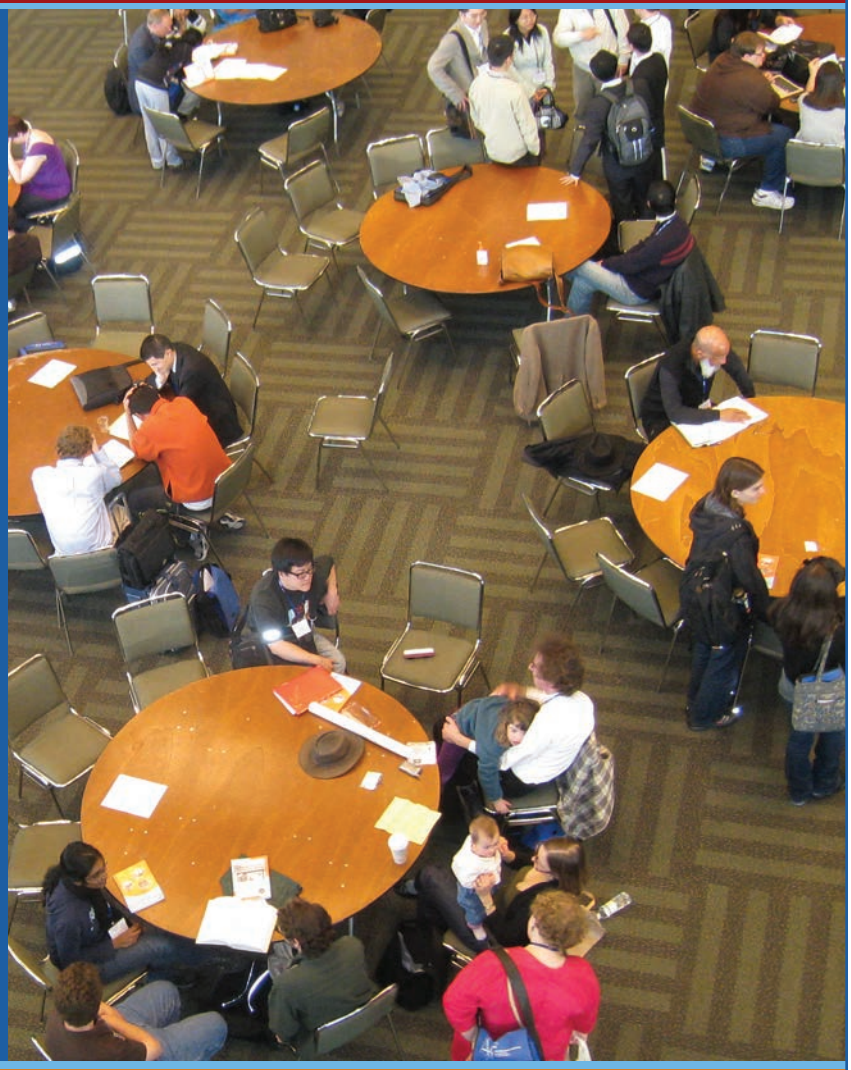

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# Mathematics in Kenya

*Tom Denton*

**Fishermen on Lake Victoria.**

I became involved in math education and research in Kenya in 2010 during the last year of my PhD. I was interested in doing some work in a developing country, and Kenya had the advantage of being both English-speaking and the place where my girlfriend at the time was setting up her own PhD research. So I wrote about fifty emails to people who looked like they might be interesting to talk to from all over the Kenyan university system.

Exactly one person responded, and two months later I embarked on my first trip to western Kenya. My contact was Dr. David Stern, a UK citizen who had grown up in Niger (his father, Dr. Roger Stern, is a well-known statistician working on climate issues), did a PhD in topology at the University of Warwick, and then took a post at Maseno University in Nyanza Province, where he had been for the last five years. He had a coterie of successful graduate students, all with a passion for math education.

I first travelled to Kenya for two weeks in November 2010. During that first trip, I worked alongside a British PhD student and a South African professor. We helped Kenyan graduate students grapple with their research topics and gave some workshops on our own research interests. (Mine, I believe, was on crystal bases.) Six months later I went back to Kenya for the first Maseno Maths Camp. Six months after that, I submitted an application for a Fulbright Scholarship from the US State Department, which I was awarded in 2012.

Mostly this is the story of the year I spent in Maseno from 2012 to 2013, what I saw of mathematics in Kenya, and the projects I worked on directly. My host during that time was Dr. David Stern, the mathematician I initially contacted in 2011. David is a man of sweeping vision who watches TED talks in his spare time and, if there's a bit of justice in the world, will give a couple himself in due time. It takes a certain kind of passion to completely jump outside all the known career paths for a Western mathematician to take a job in Nyanza Province, so far even from Nairobi. And it requires dedication to stick with it for half a decade in the face of abysmal pay, difficult working conditions, and incessant car trouble.

In exchange for all this hardship, though, there's massive opportunity for impact. There are problems to be addressed at every turn and an incredible number of opportunities to try things out and see what works. During my year in Kenya, I taught undergraduates, both face-to-face and in an online course; mentored graduate students; taught graduate workshops; cofounded a hacker

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*Unless otherwise credited, all photos are the property of Tom Denton.*

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space; ran teacher trainings; and coordinated maths camps for secondary schools. Some things worked amazingly well, and others, like the teacher trainings and a regular seminar on representation theory, failed miserably. This is the one place I've seen in academia where the ethos of "launch and pivot" was most in evidence.

You can have a hundred conversations in Kenya and almost all of them will contain the phrase "You see, the problem is…," and the problem will never be the same. Mathematics is the language of problem solving: my work in Africa was an effort to help people find the tools to define their problems and to build their own innovative solutions.

## Maths Camps

The idea of offering a "maths camp" for secondary school students and their teachers came from Zach Mbasu, one of David's graduate students, following a successful effort to get statistics software into nearby secondary schools. As of January 2015, four maths camps have been offered at Maseno University (Kenya), two at Bahir Dar University (Ethiopia), and one in Ghana. Numerous one-day "camps" in schools all around Kenya have also taken place.

The basic model is to teach mathematical concepts in fun and engaging ways with a combination of local and international instructors, consisting of UK school teachers, Peace Corps volunteers, and whichever scientists and mathematicians we can get to put aside a couple weeks of their time. All of the instructors and coordinators get together for a week beforehand and spend an intense seven days plotting out curriculum for the five days of camp. We typically design five "courses": past subjects have included computational statistics, combinatorics, modular arithmetic, cryptography, epidemiology, mathematical card tricks, groups and symmetry, computer programming (the only subject that doesn't use computers), and more. Contentwise, we strive to design activity-based sessions which build up, one on the next, as the week progresses—the sorts of sessions you might expect in a high-quality math circle in the US. We finish the week with sessions that are more talk-oriented on subjects that follow from what we've already explored while really pushing the limits and demonstrating that there's a whole world out there waiting to be explored.

One of my favorite sessions starts with a two-player game called Fifteen. The players take turns picking numbers between one and nine (without replacement) until either all of the numbers are exhausted or one player wins by getting a set of exactly three numbers that add up to fifteen. We start with some free play and exploration and ask students for any strategies or patterns that they've noticed. We then enumerate all of the different ways to make fifteen, usually in response to a question of whether any numbers are "better" than others. A bit more guidance leads to building a magic square, where the rows, columns, and diagonals all sum to fifteen. Playing Fifteen on the magic square is exactly the same as playing tic-tac-toe: we reduce a hard computational problem to a completely trivial game of three-in-a-row. Depending on time, we might then find all of the magic squares (since each student comes up with their own arrangement) and explore the symmetries of a square along the way. A counting argument and a Cayley graph provide an easy check that we've not left anything out.

We use quite a few card games in the maths camps. The rules of games are analogous to mathematical axioms: though the rules are arbitrary, we try to find rulesets which provide us with interesting play and follow them precisely once chosen. Playing a few different variants of, say, Rummy shows the different effects that can occur from slight changes in a set of axioms. Building strategies in a card game is similar to forming a conjecture (or, with a bit more work, proving a theorem).

African Maths Initiative, 2012.

**Students playing learning card games at the Maseno Maths Camp.**

African Maths initiative, 2012.

**A game of Set at the Maseno Camp, with instructors from the US, UK, and Ethiopia.**

**Professor Ruriko Yoshida rides a camel following a graduate workshop.**

In truth, playing cards is usually forbidden in Kenyan schools, associated with gamblers and ne'er-do-wells. But many of the teachers we have worked with have decided to stop confiscating playing cards, as they are so rich in mathematical possibilities.

Our goal with the maths camps is to introduce secondary students to the beauty of mathematics and give them some experience with working with mathematical concepts. Both the primary and secondary school systems in Kenya are directed at the national exams, with their overwrought curriculum. Teaching focuses on how to get the answers to test questions without any reflection on why the methods of solution work or, in the worst cases, what the questions are even asking. We want to leave students with a sense of the importance and relevance of mathematics, alongside a sense of personal enjoyment of the subject.

We teach all of the students a theme song that I wrote for the second Maseno camp. The refrain goes:

> You can't get away from mathematics,
> and once you've been to maths camp
> you wouldn't want to try.
>
> Coz there's a beauty in the order that
> surrounds us, invisible until you find
> the rules of how and why.

The camps have been quite successful. We regularly hear from teachers about students excelling in their school math classes after coming back from the maths camp. Our ideal student is someone who isn't necessarily already interested in math, but who is gregarious and curious and likely to go home and spread the ideas from maths camp to their friends. We send students home with DVDs of free and open source math software (like Geogebra), which often find their way into schools' computer labs. In one case, a school actually secured funding to create a computer lab in response to a student who showed up with one of our DVDs.

Small measures like these help increase our impact. We can only work with a tiny fraction of the 400,000 students who graduate each year, so we strive to create as many second-order effects as we can. To that end, we also invite school teachers to attend the camp. I've found teacher training in Kenya to be generally ineffective, largely because teachers often don't believe that alternative methods can be effective. The camps give us a way to show teachers directly what activity-based sessions can do for students.

## Undergraduates and Online Homework

The required mathematics classes at Maseno University generally have between three hundred and six hundred students, with no teaching assistants. Each professor also generally has a full teaching load of four classes, possibly with some extra teaching on the side to supplement his or her income. It should come as no surprise, then, that there is almost no evaluation. A midterm and a final are offered, and the midterm generally hasn't been graded by the time the final is given. Classrooms are either grossly overcrowded or so cavernous that the board can't be seen by most of the class. And so on.

One of the more successful simple measures I discovered to deal with some of these issues was to integrate online homework systems (specifically, WebWork) into existing classes. I personally helped get WebWork into a calculus class with four hundred students and a linear algebra class with six hundred students, and helped Mary Achieng, lecturer at Strathmore University, use WebWork with four of her classes.

Online homework systems have their shortcomings, of course—it's difficult to go beyond rote learning—but the benefits in this context were substantial. The obvious benefit is that computer grading allows students to get instantaneous feedback on whether they've found a correct answer or not. Every student gets different numbers in their problem set, so one can't directly copy the work of another student. Giving five chances to complete each problem also provides space for getting a problem wrong and learning from mistakes and reduces the incentives for cheating.

These are the standard benefits of WebWork. In my classes in the US and Canada, I've found a combination of WebWork (for drills) and written homework (for proofs and concepts) to be immensely effective. The combination emphasizes the need to know how to work carefully towards a correct answer and the separate need to understand the how and why of a line of reasoning. Unfortunately, there is little opportunity for grading written work when working with students at the scale of these Kenyan classes.

There are two added benefits to WebWork in Kenya, however. We found many undergraduates were under the impression that computers were for computer science students. WebWork forced these students to interact with computers on a weekly basis, building basic computer literacy while also demonstrating that there's a relationship between mathematics and computation. More

concretely, weekly time in the computer lab gave students the chance to augment their lectures with videos from the Khan Academy and articles from Wikipedia, which they never would have engaged with otherwise.

All of that said, there are at least two large hurdles to using WebWork at scale in Kenya. The first is the difficulty of getting support for lecturers to use the system: widespread adoption would require funding for training and on-site support. The second is that WebWork could use some serious work on the user interface side. For example, the process for creating new problems involves writing in specialized Perl libraries, which is a lot to ask of math lecturers in Kenya. Overall, however, WebWork is a fantastic tool and, taken up on a large scale with the right level of support, would have a good chance to vastly improve math education in Kenya and many other developing countries with similar problems.

Professor Gunnar Stefánsson of the University of Iceland is developing another online homework system called Tutor-Web, which has been piloted at Maseno University by lecturer Victoria Warain. Gunnar's system scales the difficulty of problems to the ability of students, using an interesting statistical evaluation of problem difficulty and interrelatedness. This raises some interesting problems for evaluation in the classroom: If student X gets twenty easy problems right, while student Y gets five hard problems right, how do we assign them meaningful and useful grades? Gunnar and his graduate students have been doing some great work resolving these questions of evaluation and improving student incentives. The system is aimed at creating a richer interactive experience for the students and certainly comes with all of the added benefits of online homework systems in the Kenyan context. Gunnar's system also requires less in the way of ongoing IT support, which is a significant bonus.

The simple effectiveness and impact of the online homework systems should be briefly contrasted with some other efforts at online education I was involved with. Maseno University has an online learning program, for which I taught a section on abstract algebra. There was a clear problem of enrollment: the first run of the course had eight students, and the second (which I begged out of) had just one. Compared with the hundreds of students overwhelming the face-to-face sections, it's clear that the online components aren't meeting the needs of traditional students. I put a significant amount of effort into creating a system of online notes for the course, as well as a set of video lectures, which have mostly gone unused.

Online homework systems are a key component of a "hybrid" education model where humans and computers are each put to their best effect. Human involvement in the classroom creates a social bond

**Fishermen on Lake Victoria.**

**Vervet monkey on our roof in Maseno.**

with the class, a sense of ongoing obligation, while also providing a forum for interactive conversation about the material that is often lacking in MOOCs. Within the Kenyan context, where uptake of technology and the Internet is still quite low and emphasis on traditional credentials is high, a full move to online education is unnatural for students and lecturers. Online homework systems provide a way to create more technologically savvy students without leaving them overwhelmed or lost, improving without abandoning the existing educational system.

## Graduate Students and Research

I am not quite sure how to describe the state of Kenyan postgraduate work without sounding overly dismal or insulting to people who are trying their best in difficult circumstances. Suffice to say that the Kenyan mathematical community has been almost entirely isolated for much of the last thirty years. Former President Daniel Arap Moi (1978–2002) can probably take some of the blame for this directly. Moi was a man with a sixth-grade education, famously unconvinced of the benefits of higher education. The minimal state funding for the universities led to a scramble to enroll as many students as possible, with results that the American audience should be mindful of. Teaching overcrowded classes became the main work of the university, leaving little time for research and conferences.

African Maths Initiative, 2012.

**Instructors on excursion at the Ethiopian Math Camp.**

One of the most heartening efforts I've seen, though, is a cluster of young researchers from the University of Nairobi who have decided to collectively pursue algebraic geometry abroad, with the intention of coming back to Nairobi and having a functioning research group. (One of their number, Jared Ongaro, is notable also for cofounding the Kenyan Math Olympiad, another excellent effort to break the isolation.) In July 2013 this group, led by Professor Patrick Weke and Dr. James Katende, organized a three-week workshop on applicable algebraic geometry which went above and beyond any of my expectations for such a workshop. Professor Balazs Szendroi of Oxford (who has been involved in Kenya for some years) assembled a team of seven international lecturers, and Professor Gavin Brown headed the scientific coordination. The topics ranged from introductory linear algebra and commutative algebra in the first week to Dr. Ruriko Yoshida's introduction to algebraic statistics in the third week.

What set this workshop apart was the core of focused participants from the University of Nairobi, who came with some prior affection for the subject matter, led the charge during our interactive problem sessions, and worked with other participants on problem sets late into every evening. Local initiative makes all the difference.

On another front, Strathmore University has started an East African Mathematics Conference, now in its fourth year. Because the research community is relatively small, the conference has a broad focus. It begins with workshops in pure and applied mathematics, math education, and research methods, and then has a few days of presentations from invited speakers. With an audience coming in from across Africa and a sizable European contingent, the conference is an excellent step towards bringing Kenya into the international math community.

Finally, the African Institute of Mathematical Sciences (AIMS) is doing a fantastic job of building bridges. While there's no branch yet in Kenya, I have met numerous people who have benefitted from time at AIMS centers. I also had the opportunity to teach at AIMS in South Africa in January 2013, alongside Dr. David Stern, and to see their model firsthand. AIMS brings in lecturers from around the world to lead three-week sessions with the best African graduate students in math and physics. Behind the scenes AIMS is engaging their host countries to pay half of the costs of running each center, creating a precedent for serious government funding of science and research. In time, the stream of students going back to their home countries will build a critical mass of researchers and educators, and African mathematics will flourish in its own right.

## Hackerspaces

A variety of technology hubs have popped up across Africa in the last few years. They serve a number of roles, providing space for skill-sharing and coworking, business incubation, hackathons, unconferences, barcamps, and more. The most famous is the iHub in Nairobi, which acts as the de facto heart of the Kenyan technology community. I've met dozens of fascinating people in my visits to iHub. It was also where I first saw and tried Google Glass.

In early 2013 I attended TEDx: Kisumu. Kisumu is Kenya's third largest city and the city closest to Maseno (a bit less than an hour's drive depending on the rain and the roadblocks). We had heard somewhat randomly of the event and had only a faint idea of the tech community in Kisumu at the time. The event was a live screening of another TED event going on in Hawaii, focused on disruptive innovation. At the end of the night, as the bunch of strangers milled about uncomfortably, a couple of the coordinators rounded everyone up into a circle and forced us into conversation.

The coordinators, Herbet Kisara, Simeon Obwego, James Odede, and Evan Green-Lowe, were mostly working with international non-governmental organizations (NGOs) but interested in jumpstarting a tech community in Kisumu. They had been kicking around the name "LakeHub" in their own conversations, and by the end of the night the group had resolved to host LakeHub's first event. A month later we hosted a design-thinking workshop in a Kisumu hotel.

Design-thinking is an attempt at formalizing the process of innovation, starting with identifying problems to engage with, followed by solution brainstorming, narrowing of ideas, revisiting the initial problem, and building and iterating on prototypes. Our workshop was focused on building a better wallet, with an initial turnout of about thirty people.

Following that event, we secured a space at a local coffee house for weekly presentations and skill-sharing. I gave presentations on proper

password storage (salted hashes), programming in Python, and game design, while others gave bare-knuckle intros to app development for Android phones, tutorials on building websites for businesses, and Arduino programming. Recently, LakeHub moved into its own permanent space in Kisumu and continues hosting regular events. They have had funding from Google for a high school outreach program, CS4HS, and ongoing involvement with Maseno University's CS program and the growing tech community in Nairobi.

LakeHub's core constituency is a diverse mix of people, including students and people who took a CS degree but for one reason or another didn't move to Nairobi. The community also includes business people with an interest in technology and Kisumu's few tech freelancers, a network of people who, prior to LakeHub, were there but mostly unconnected. It is, to the best of my knowledge, the first stable tech hub in Africa outside a capital city. This is vital; some 80 percent of Kenya's population is rural, which means that Kenya's problems are mainly rural problems. In the long run I'm hopeful that LakeHub will provide a place for Kisumu's tech community to start tackling some of these rural problems.

## Epilogue

When you start working in the developing world, you start seeing a lot of abandoned wells. Water-carrying is easy to identify as a problem with a fairly simple technical solution: build a better pump. The proposal gets written, the pilot goes well, and a couple of years later hundreds of pumps of a certain design start popping up in rural villages, funded by large non-governmental organizations (NGOs) and installed by smaller NGOs. After a while, a flaw becomes apparent in the design, but with no local factories to supply spare parts, poor transportation networks pushing up the price of nonlocal parts, and the end of the original grant passing by, the well falls into disrepair and disuse. The NGOs involved may not even be aware of the problems if they don't have a long-term presence in the hundreds of villages in which they've installed the pumps. (While presented here as a parable, you can Google the PlayPump to see a real-world example.)

I aim in my work to avoid building abandoned wells, which means trying to work around some classic root problems mainly having to do with the disconnect between the NGOs and the local communities. Transient NGOs often misidentify problems in a local community or else come up with solutions that can't possibly work in the local context. By teaching essential problem-solving skills, including fundamental math and statistics, we give people the tools to better understand the world around them and build sustainable solutions to the problems they identify in their communities.

African Maths Initiative, 2012.

**Ethiopian Maths Camp students at the source of the Blue Nile.**

Computer science increasingly gives a path from understanding to a low-cost solution, whether through websites for undeservedly obscure tourist destinations, GPS tracking on fishing boats, farm-to-market apps, or customer databases for predicting demand for goods. I aim to give people the tools to understand and to build, to innovate and to iterate.

After returning to Canada I had one year left of a postdoctoral placement, meaning I was immediately starting a job search. After a great deal of soulsearching, I decided to take leave of academia for a while and took a job with Google. My reasons were many but included a sense that the job and tenure process is focused on impact factor at the expense of actual impact. I came through the job process with the feeling that the "later, later" of career-building leaves many kinds of important work—like outreach or building better software—by the wayside. My work in Africa seemed to be seen primarily as a lower publication count. With Google I am working at global scale, drawing heavily on my background in mathematics while dealing with the limitations of applications. I am picking up skills that will be useful in future work in Africa while making enough of a salary to fund other initiatives I really believe in. Google's extensive outreach efforts in the developing world also provide opportunities to stay involved with the projects I have outlined above.

If you're interested in doing this kind of work, I highly recommend getting in touch with AIMS or the African Maths Initiative, the organization we founded to run the maths camps. There are also very few Fulbright applications in mathematics for sub-Saharan Africa, and the international interest in building STEM capacity gives these applications extra weight.

# Search for an Executive Director for the American Mathematical Society

### Position

The Trustees of the American Mathematical Society seek candidates for the position of Executive Director of the Society to replace Dr. Donald McClure, who plans to retire in the summer of 2016. This position offers the appropriate candidate the opportunity to have a strong positive influence on all activities of the Society, as well as the responsibility of overseeing a large, complex, and diverse spectrum of people, publications, and budgets. The desired starting date is July 1, 2016.

### Duties and terms of appointment

The American Mathematical Society, with headquarters in Providence, RI, is the oldest scientific organization of mathematicians in the U.S. The Society's activities are mainly directed toward the promotion and dissemination of mathematical research and scholarship, broadly defined; the improvement of mathematical education at all levels; increasing the appreciation and awareness by the general public of the role of mathematics in our society; and advancing the professional status of mathematicians. These aims are pursued mainly through an active program of publications, meetings, and conferences. The Society is a major publisher of mathematical books and journals, including MathSciNet, an organizer of numerous meetings and conferences each year, and a leading provider of electronic information in the mathematical sciences. The Society maintains a Washington office for purposes of advocacy and to improve interaction with federal agencies.

The Executive Director is the principal executive officer of the Society and is responsible for the execution and administration of the policies of the Society as approved by the Board of Trustees and by the Council. The Executive Director is a full-time employee of the Society appointed by the Trustees and is responsible for the operation of the Society's offices in Providence and Pawtucket, RI; Ann Arbor, MI; and Washington, DC. The Executive Director is an ex-officio member of the policy committees of the Society and is often called upon to represent the Society in its dealings with other scientific and scholarly bodies.

The Society employs a staff of about 200 in the four offices. The directors of the various divisions report directly to the Executive Director. A major part of the Society's budget is related to publications. Almost all operations (including the printing) of the publications program are done in-house. Information about the operations and finances of the Society can be found in its Annual Reports, available at www.ams.org/annual-reports.

The Executive Director serves at the pleasure of the Trustees. The terms of appointment, salary, and benefits will be consistent with the nature and responsibilities of the position and will be determined by mutual agreement between the Trustees and the prospective appointee.

### Qualifications

Candidates for the office of Executive Director should have a Ph.D. (or equivalent) in mathematics, published research beyond the Ph.D., and significant administrative experience. The position calls for interaction with the staff, membership, and patrons of the Society as well as leaders of other scientific societies and publishing houses; thus leadership, communication skills, and diplomacy are prime requisites.

### Applications

A search committee chaired by Robert Bryant (bryant@math.duke.edu) and Ruth Charney (charney@brandeis.edu) has been formed to seek and review applications. All communication with the committee will be held in confidence. Suggestions of suitable candidates are most welcome. Applicants can submit a CV and letter of interest to:

Executive Director Search Committee
c/o Carla D. Savage
Secretary, American Mathematical Society
Department of Computer Science
North Carolina State University
Raleigh, NC 27695-8206
ed-search@ams.org

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# William B. Arveson: A Tribute

*Daniel Markiewicz and Palle E. T. Jorgensen, Coordinating Editors*

Source: Oberwolfach photo collection, copyright George M. Bergman, Berkeley.

**William B. Arveson**

William Arveson's work has been extraordinarily influential, and it is known to everyone in functional analysis and in operator algebras. Bill's career spanned UCLA, Harvard, and (since 1968) UC Berkeley, where he had twenty-nine PhD students and also mentored several postdocs. As we prepared this tribute we were struck by the sheer number of spontaneous notes or comments from mathematicians who felt personally inspired by his papers in the beginning of their careers.

Functional analysis and operator algebras owe much to Hilbert's and von Neumann's pioneering visions for a rigorous mathematical foundation of quantum mechanics (Hilbert's Sixth Problem [19]; see also [8]). Two other areas motivated these subjects from the start: ergodic theory and the study of unitary representations of groups, especially the Lie groups arising in relativistic quantum theory.

The noncommutativity that lies at the heart of quantum theory exerted great fascination for Bill. His work was often inspired by problems from physics, but this was by no means the full story. Over decades, Bill pioneered making sense of deep questions regarding noncommutative harmonic analysis, operator theory, and operator algebras. These developments had great impact on modern analysis and propagated to other fields. Bill produced many "pure" theorems of unusual elegance and striking beauty, and we refer the reader to two recent survey articles on some of his many contributions to mathematics: [7], [13].

In the following we include several articles from Bill Arveson's colleagues written especially for this tribute. In order to comply with the space assigned by the editors, the articles have been shortened substantially. For the full version see www.math.bgu.ac.il/~danielm/share/arveson-memorial-article.pdf.

## *Kenneth R. Davidson*

Bill Arveson completed his doctorate in 1964 at UCLA under the supervision of Henry Dye. After an instructorship at Harvard, Bill started a long career at the University of California, Berkeley. I was a student of his in the early to mid-1970s. Bill was still young but already had had a strong influence on operator theory and operator algebras. The influence of this early work continued to grow in the following decades.

Arveson's work was deep and insightful and occasionally completely revolutionary. When he attacked a problem he always set the problem in a general framework and built all of the infrastructure needed to understand the workings.

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This perhaps is the reason that his influence has been so pervasive in many areas of operator theory and operator algebras.

I will skip ahead in time, passing by many important results, to the current century. Arveson tackled the problem of multivariable commutative operator theory. The ideas of dilation theory, now well established, suggest that one should understand the universal operator algebra determined by appropriate algebraic and norm constraints. A number of authors in the noncommutative setting had observed that a row contractive condition was proving to be much more amenable than insisting that individual generators be norm one. Bill applied this to an $n$-tuple of commuting operators. The canonical model that he developed was the space of multipliers on symmetric Fock space. This space turned out to have other remarkable properties. Arveson showed that it was a reproducing kernel Hilbert space of functions. David Pitts and I showed that it was a complete Nevanlinna-Pick kernel, and Agler and McCarthy showed that it was the universal complete NP kernel. These three results came from different directions but served to make operator theory on this space a rich venue for analysis and algebra.

Bill went on to write a long series of papers on this operator algebra. He introduced many ideas from commutative algebra into the program. He developed a notion of curvature as a key invariant for commuting row contractions and many other ideas. He made an important conjecture which has generated a tremendous amount of work by many authors. As with his earlier work, he had the good taste, the vision, and the mathematical power to establish a powerful new approach to an important problem.

This is his legacy, a deep and powerful vision of operator theory and operator algebras as an integrated whole. He brought ideas from function theory, harmonic analysis, commutative algebra, geometry and physics to bear on problems in operator theory and operator algebras (two areas I am sure that he considered as one) and produced works of art that have attracted almost every practitioner of this subject at some time. He has had a profound impact, and this impact will continue for a long time to come.

It is my honor to have been a student of Bill's. His work influenced me more than most, since most of my work, traced to its roots, goes back to Bill in some way. I am glad that I had the privilege to know him.

## *Ronald G. Douglas*

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Photo courtesy of Marcelo Laca and Juliana Erlijman.

**Bill Arveson and some of his students at COSy 2006. From the left: Marcelo Laca, Ilan Hirshberg, (Bill), Michael Lamoureux, Kenneth R. Davidson, and Donal P. O'Donovan.**

In January 1965, after giving a ten-minute talk at the annual American Mathematical Society meeting, held that year in Denver, a graduate student came up to me and asked a question. I don't recall what he asked, but I do remember the event because it was the first time I met Bill, and our mathematical careers became intertwined from that point on. We became, and remained, strong friends and colleagues over the next almost fifty years.

In the early seventies, I collaborated with Larry Brown and Peter Fillmore to produce the body of results usually known as BDF theory. Classes of operator algebra extensions were made into an abelian group which could be calculated, resulting in some then rather surprising results in operator theory. I had many discussions with Bill in the middle seventies in which he wrestled with these ideas, trying to fit them into his context. No surprise—he did! He saw the bigger picture relating the group structure to certain questions in operator algebras involving completely positive maps and nuclearity.

The machinery connected with BDF theory that Bill provided helped extend the ideas and provide the extension framework for Guennadi Kasparov's KK-theory. Further, revolutionary development of these ideas by Alain Connes, Kasparov, and many others led to the Special Year at MSRI in Berkeley in 1984–85. By this point, Bill was well on his way to inviting an outstanding group of young mathematicians into the field, and his seminar was a must for everyone interested in linear analysis, both as a speaker and as an attendee. Bill also participated in the social life surrounding the program at MSRI. On one Friday evening, he offered

Photo courtesy of Lee Kaskutas.

**Bill Arveson with Edward Effros.**

to show a group of perhaps ten, "his San Francisco." After dinner and wandering through the North Beach area, we ended up at Carol Doda's club, where she invited Bill on stage to join her. Bill didn't disappoint.

While attending a conference at Berkeley in February 2003 honoring Donald Sarason, Bill told me that he had come upon a problem he wanted to discuss with me. During the rest of that year and at conferences that December in Bangalore and Chennai, we discussed his problem. He was trying to get $C^*$- or quantum models for projective varieties in $\mathbb{C}^n$. He sought to show that the closure of a homogeneous polynomial ideal in the symmetric Fock space is essentially normal; that is, the cross-commutators of polynomial multipliers and their adjoints are compact. (Actually he conjectured that they are in the Schatten-von Neumann $p$-class for $p$ greater than $n$.) He was able to show that this was the case for homogeneous ideals generated by monomials but not in general. I became intrigued and was able to extend his results modestly. Both Bill and I announced, at different times, proofs of the conjecture, which turned out to be incomplete. In talks Bill spoke of the witch's curse on this problem, and indeed at least one other incorrect proof has been announced since then. The question is deep and has attracted the attention of researchers around the world, but the general case remains open.

## *Edward G. Effros*

The functional analysts at UCLA were devastated by the news that Bill had passed away. He was one of the key figures in the development of noncommutative functional analysis and its applications to a wide range of mathematical disciplines. I will largely restrict my remarks to several of Bill's papers on linear spaces of operators.

One of Bill's most influential discoveries was that one could develop a theory of boundaries for the operator algebraic analogues of function algebras [1]. His key observation was that linear spaces of operators have a hidden matricial structure that must be incorporated into the theory. This rests upon the fact that a matrix of operators is again an operator, and thus the matrices over an operator space form again an operator space. The ordering and norms of such matrices are essential parts of the relevant structure and must be acknowledged by the morphisms, i.e., by the completely positive and completely bounded operators.

Although complete positivity had been investigated earlier by Sz. Nagy, Stinespring, and Umegaki, Bill was the first to appreciate the power of these notions. The crowning achievement of his early theory were analogues of the Hahn–Banach theorem for completely bounded and for completely positive mappings (put in its final form by Wittstock [20]). He used this theory to prove important results about matrix numerical ranges.

Soon the young operator/functional analysts jumped on the matrix ordered version of Bill's theory (operator systems), and before very long the injective (or semidiscrete) von Neumann algebras were characterized as being the hyperfinite von Neumann algebras (work by Connes, Choi, Lance, and me). Of course, there were many other directions to be pursued, and within a few years the nuclear $C*$-algebras were determined (Choi and me, and some parallel work by Kirchberg), and lifting theorems were proved (relevant to KK theory).

Owing to Ruan's axiomatization of the operator spaces (the quantized Banach spaces [17]), the full significance of Bill's approach to matrix norms is now also understood. This has enabled researchers to find noncommutative analogues of many of the notions of Banach space theory (see [9], [16]). Very recently, the matrix ordered operator systems have seen an upswing of interest, due to the work of Vern Paulsen and his colleagues [15]. Yet another application of these ideas may be found in the abstract characterization of the nonself-adjoint unital operator algebras [6]. This provides an elegant framework for Arveson's original investigations.

Bill's interests ranged over a wide range of subjects, and he influenced several generations of mathematicians. A particularly intriguing example of this work was his theory of continuous tensor products, which was also pursued by Bob Powers and then by Boris Tsirelson. What was truly remarkable about Bill was that his productivity never declined throughout his mathematical career. He was always ready to tackle a completely new area. This is illustrated by some of his last papers,

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which are concerned with quantum information theory.

Although I have never worked on noncommutative boundary theory, I would be remiss if I did not recount one of Bill's most spectacular recent results. Nearly forty years before, he had posed the problem of determining if operator systems have sufficiently many boundary representations. Important contributions had been made by a number of individuals, including Dritchel and McCulloch, Muhly and Solel, as well as Ozawa. In [3] he finally succeeded in proving the result for separable operator systems by using delicate direct integral techniques. This is an old-fashioned technology (dear to my Mackey heritage) that might not have been appreciated by his younger colleagues.

Upon the appearance of that work, I couldn't resist writing to him that he "had shown all those young whippersnappers a thing or two." He gleefully replied that he shared that opinion, and then he characteristically sent me a fascinating paper on operator systems on finite-dimensional Hilbert spaces [4]. I am only just beginning to realize its importance.

Having summarized so much of Bill's professional accomplishments, I would like to add a final personal memory that summarizes how nonmathematicians viewed Bill. I was with my family at Victoria Station in London, probably in the late 1980s, awaiting the train to a math conference somewhere in the UK when we bumped into Lee (Bill's wife) and Bill, who were en route to the same meeting. We all spoke for a while, then moved on so that we could get a bite to eat. Our teenage daughter asked how we knew these two people, and I mentioned that Bill was a mathematician. Having met many of my colleagues over the years, she looked totally shocked and said, "That guy seems much too cool to be a mathematician!"

Bill, you will be irreplaceable.

## *Richard V. Kadison*

Bill and I met during his graduate student days at UCLA. He reminded me of that, with a smile, on a few occasions each time I said that we had met during the so-called "Baton Rouge Conference" (at LSU in March of 1967). After two or three corrections, much to Bill's amusement each time, I finally got that straight (I'm a slow learner, but then I retain it tenaciously). As I was just noting, when I first met Bill at that Baton Rouge conference the year was 1967, the same year in which Bill's great paper in *Amer. J. Math.* appeared. We'll have more to say about that paper at a later point. It was clear to me that Bill was a very smart young

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Photo courtesy of Palle E. T. Jorgensen.

**From the left: Daniel Kastler, Marcelo Laca, Paul Muhly, Hans Borchers and Bill Arveson at a conference at the University of Iowa in 1985.**

mathematician. What I hadn't known, until we had that time to talk to one another, was that Bill had a personality that was very congenial to my own way of doing and thinking about things. Bill was articulate and clear, with the kind of humor that I enjoy. He had a candor, at least when talking with me, that I appreciated. It wasn't "kick-in-the-shins" candor, the kind that hurts people without much extra purpose. When I listen to some people who pride themselves on being "candid," I feel that they are deriving at least as much pleasure from being cruel as from being "forthright." I never detected one scintilla of cruelty in Bill's interaction with people. What one could observe about Bill was that he had an abundance of what the young people these days call "cool." At a conference in England (Durham, I think) that Bill, Ed Effros, and I were attending, I talked to Rita Effros during a lunch break. She reported that her son, then a youngster, had remarked to her the preceding evening that "Bill Arveson was the coolest mathematician he had met." At the same moment in which she told me that, she realized that she might have offended me by not saying that her young son thought that I was cool as well. Now, Rita is as sweet and kind as they come, to which everyone who knows her will attest. But level of coolness is not one of the axes in my personality description on which people are prepared to place a mark. Bill's "cool credentials" are, however, unassailable. …

At this point, we've come full circle; we are back to Bill's 1967 *Amer. J. Math.* paper [5]. In section 4.3 of that paper, Bill speaks of "determinants" in a von Neumann algebra setting. He cites the "determinant" that Bent Fuglede and I introduced [10], [11] and used to answer a question we had asked ourselves: Must a generalized nilpotent operator in a $\mathrm{II}_1$ factor have trace 0? We proved, using that determinant, that the trace of each operator lies in the closed convex hull of the spectrum of the operator, which of course provides a positive answer to the question about generalized nilpotents. Bill notes that our determinant applies to more general circumstances than the $\mathrm{II}_1$ factor case without the least difficulty; statements, definitions and proofs, remain virtually unchanged. One has, for example, the extension

to general, finite von Neumann algebras, where a fixed tracial state is used in place of the trace itself in the factor. Using this determinant, Bill states and proves a generalization of the Hadamard determinant inequalities [12], mentioned in the report to Is Singer. It involves the tracial state and a conditional expectation that "lifts" it. This occurs in section 4.3. In section 4.4, the final section of Chapter 4, Bill formulates an extension of Jensen's inequality in terms of Bill's "subdiagonal algebras," the determinant, a conditional expectation onto the "diagonal" of the subdiagonal algebra, and a tracial state that lifts it.

In some inexplicable way, my browsing in Bill's paper back near the time it first appeared had been, at most, superficial.

It's not too daring to predict that he will be in the thoughts of many mathematicians for many years to come.

## *Marcelo Laca*

It is difficult for me to imagine the world without Bill Arveson, mathematician, mentor, and friend. The recognition that he left behind an extremely rich mathematical legacy, both in print and in the minds of those he inspired, is only a partial consolation. He also left behind a wonderful network of friends and colleagues who will remember him fondly and miss him sorely. I had the privilege of doing my PhD with him in a period that shaped the rest of my life, and I would like to take this opportunity to reminisce and give a glimpse of what it was like to have Bill as an advisor and also to share some of his advice. Other aspects of Bill's professional life and his many contributions to mathematics are described elsewhere by others.

I am convinced that when Bill did mathematics, he just thought differently from everyone else I know; his was a very intimate thought process that was not complete and could not be shared until he had the perfect way of presenting the big picture, frame and all. Many of his papers became hugely influential in the field, and for all I know, many others are just awaiting rediscovery to achieve a similar fate, for Bill's ideas are deep and timeless. His work is all the more impressive considering that he worked almost exclusively by himself and that he only published what met his high standard. His research touched upon many areas. One common thread was that he preferred to deal with challenging problems, another was the principle that to be properly understood, problems should be put in operator algebraic terms. Only once or twice I got the feeling that something I was saying was news to him, but, in any case, the interval between "that cannot be true" and "I see" was never long enough to enjoy. He was very generous with credit and with his ideas. Embedded in his explanations there were often priceless jewels of his original insight, which he simply gave away as part of his approach to the subject. These keep cropping up once and again in my mathematical life, evoking no small amount of admiration, gratitude, and nostalgia.

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## *Paul S. Muhly*

I had the wonderful good fortune to spend the 1977–78 academic year on sabbatical at the University of California at Berkeley. It was an extraordinarily stimulating experience, but my most vivid memories are from the times I spent talking with Bill Arveson. Among the many things we discussed were his papers, "Subalgebras of $C*$-algebras I & II" [1], [2]. I was already very familiar with them. Indeed, I had spent a lot of time studying them. I found them full of inspiration, and after more than forty years I still do.

So I was taken aback, early in our discussions, when Bill expressed disappointment that "Subalgebras I" had not received more recognition. It was Bill's most heavily cited paper and it continues to be No. 1, with almost one hundred more citations on MathSciNet than the runner-up. One might think, therefore, that Bill was being greedy. He was not, and I would like to take this opportunity to explain why.

Bill wrote [1], [2] in order to set the stage for studying general, not-necessarily-self-adjoint operator algebras. He drew inspiration from several sources. First there was the seminal work of Kadison and Singer [14]. This was the first paper dedicated to studying nonself-adjoint operator algebras. Their objective had been to classify algebras of operators which are infinite-dimensional analogues of the algebra of upper-triangular $n \times n$ matrices. Bill also gained inspiration from the dilation theory that was due in large part to Sz.-Nagy [18]. Owing to the contributions of many function theoretically oriented functional analysts, dilation theory had grown into a model theory for arbitrary operators on Hilbert space. And he was inspired by developments in the theory of function algebras. This theory had arisen, in large part, to provide a functional analytic treatment of spaces of analytic functions that arise in harmonic analysis and in approximation theory. There were already very close ties between the theory of function algebras and the model theory stemming from the dilation theory of Sz.-Nagy.

I was delighted that Bill solved the problem and that finally the central thesis of [1] had been fully vindicated. Since the appearance of

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[3], there has been an uptick in the interest in [1], and I suspect—indeed, I fervently hope—that the program that Bill initiated in it will flourish for years to come. In addition to being the source of great mathematics, "Subalgebras of C*-algebras" will serve as a monument to Bill's unswerving perseverance, from which we may all draw inspiration.

## *David R. Pitts*

Most chance meetings are of little consequence. But a few are life changing. I first met William Arveson in a laundromat in Berkeley in the early 1980s, and in the ensuing conversation I learned he was a mathematics professor, and he learned I was a mathematics graduate student. The circumstances amused us both. Shortly afterward, I remember thinking that would be a remarkable way to meet a thesis advisor. To my great fortune, Bill became my PhD supervisor a year or so later.

Arveson once told me that he published "when I have something to say." It wasn't until after completing my graduate studies that I began to appreciate the remarkable scope and impact of Arveson's work. I took Bill's advice and went to as many conferences as I could. At these meetings, I'd hear Arveson's name attached to an astonishing number of deep and pioneering results, some related to, but many others far removed from, what I'd studied as a graduate student. Bill truly had a lot to say!

I, along with many others, have benefited much from Bill's mathematics, mathematical leadership, guidance, and generosity. He is greatly missed.

## *Robert T. Powers*

I have known Bill Arveson all of my mathematical life, as I first met him at the large Baton Rouge conference in March of 1967 while I was still a graduate student in physics, a student of Arthur Wightman working in quantum field theory. I remember his enthusiasm as we talked of factors, von Neumann algebras with a trivial center. At that time I was under the illusion that problems of quantum field theory would be settled by applying the techniques developing in $C^*$-algebras and von Neumann algebras. Over the years we saw each other many times at Berkeley, Philadelphia, and at conferences all over the world.

I should say at the start that I do not enjoy reading other people's papers. I often spend weeks trying to prove a result rather than looking it up, and I tend to ignore work that does not have a direct bearing on what I am currently working on. For that reason I am not qualified to assess the impact of Bill's work on mathematics. But as much as I have avoided reading other people's papers, I could not avoid reading many of Bill's papers, which I not only read but studied to the point that Bill's ideas became incorporated into my own research. I was frankly jealous of one of his earlier papers on one-parameter automorphism groups that can be implemented by unitary group with positive spectrum, an idea from physics expounded in an early paper by Hans Borchers, in that I was well aware of the ideas leading up to it but kicked myself for not seeing Bill's brilliant thoughts for turning these ideas into gold.

Intellectually I know Bill died, but I still don't believe it. I know next spring I will think about visiting Bill and Lee in Berkeley or look forward to hearing that laugh of his regarding some recent development till I remember the hole that he has left. I only interacted with Bill in a fraction of his mathematical work, and I am sure others can tell similar stories about his significant influence in different areas of mathematics.

## *Geoffrey L. Price*

In the late 1970s it was my good fortune to be a graduate student at the University of Pennsylvania, where Dick Kadison had assembled a stellar cast of operator algebraists, including Bob Powers, my thesis advisor, and where Bill and other big names in operator algebras would come to spend their sabbatical year. Although I was too shy to speak with him, it was clear from a distance that Bill was a different sort of mathematician altogether. He was the operator algebraist's answer to Jack Kerouac or Belmondo, complete with great hair, bomber jacket, sneakers, cool demeanor, and cigarette always in hand. He had a style of lecturing in the Tuesday functional analysis seminars that was more conversation than lecture, and the ease with which he brought so many ideas to bear in his presentations was breathtaking and more than a little intimidating to a graduate student.

Another of Bill's important contributions to the subject came soon after. In his first paper Powers introduced a notion of a numerical index for $E_0$-semigroups which can be a positive integer or infinity. He was able to show that the index was subadditive under tensor products and that it was additive for the CAR-flows. Using product systems, Bill introduced his own notion of index, which agreed with the Powers index for the CAR flows. Bill established that his index was actually additive under tensor products: $d_{\alpha\otimes\beta} = d_\alpha + d_\beta$.

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Ten years later I had the good fortune to work long distance with Bill on a couple of projects, one of which involved the behavior of infinite tensor products of CP-semigroups of the type above. It was a thrill to work with one of my mathematical heroes. Bill would write to me what he'd thought about on a given day and would close by saying that it was time for a glass of wine and, according to him, further inspiration from his dachshund: "Last night I dreamed that Schnitzel said, 'Think *symmetry* stupid!', So I followed his advice and I think I found a more manageable invariant." Bill's wife, Lee, has given me his handwritten notes on that paper, and I am happy to have them here beside me.

## *Donald E. Sarason*

Bill Arveson and I were colleagues and friends in Berkeley for forty-four years. If memory serves, I first met Bill in person in Ann Arbor when he was a Benjamin Peirce Instructor at Harvard. The occasion was one of Paul Halmos's summer operator theory get-togethers.

Bill and I had many common mathematical interests, but our modus operandi were different. My attraction was to concrete problems. Bill, in contrast, always had the global picture in view. Beyond possessing an intimate grasp of the technical aspects of his specialty, he had an uncanny insight that led him to intriguing uncharted territory, coupled with the boldness to launch an exploration.

Those who knew Bill are aware that he had a stubborn streak, a beneficial trait for anyone engaged in research. Bill's stubbornness extended beyond mathematics. As anyone of a certain age will recall, the 1960s and 1970s were tumultuous times, especially on many college campuses, including Berkeley's. One day not long after he came to Berkeley, Bill entered Sproul Plaza, the main campus entrance, while a demonstration of some kind was in progress. The police were trying to clear demonstrators out and kept telling people to move on, move on. When Bill received this order he replied, "I have a perfect right to be here." He held his ground until he was suddenly seized from behind by a very large cop and hustled off to the local jail. He did not carry enough cash to post bail, but he managed to contact our chair at the time, John Addison, who got him released. I believe no charges were pressed. Bill never backed down when he thought he was in the right.

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## *Erling Størmer*

Among operator algebraists, now in their seventies or eighties, the most memorable conference they ever attended was the one in Baton Rouge in Louisiana in 1967. Then many of us met for the first time and initiated lifelong friendships. Bill and I were no exceptions. Our friendship grew over the years, as we regularly met at conferences and their like, and culminated with my three one-semester visits to Berkeley after 1998, when I enjoyed his hospitality and saw him regularly on and off campus.

While Bill was very social when he was with people, he was basically more of a loner. He worked very much by himself and mostly at home. Last time I was in Berkeley, we wrote a little paper together. It was a rather special collaboration. Our discussions mostly lasted for a few minutes when he took a little time away from his home, where his charming dachshunds were waiting for him. I remember, as the highlight, when we spent a full half hour at one of the coffee shops at Berkeley campus discussing our paper. But it was really an enjoyable and pleasant collaboration.

Much more can be said about his huge mathematical production, for example his work related to mathematical physics, in particular on entanglement in quantum information theory. But I stop here, hoping that the above gives the reader a feeling for the width and depth of his mathematical contributions.

## *Lee Ann Kaskutas*

Bill was born in Oakland. His parents divorced when he was just a year old. In his earliest years Bill was raised by his grandmother, who had come here from England. She was the first forewoman at the Levi Strauss factory in San Francisco, so was gone during the day. They lived in a house on Trask Street, and his grandmother had a lady come in to be there when Bill got home from school. Bill would walk to and from the local public grade school with a neighbor boy, who had a miniature dachshund that Bill loved to play with. Bill deeply loved his

Photo courtesy of Lee Kaskutas

**Bill holding a kitten in front of his Trask Street house in Oakland.**

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Photo courtesy of Lee Kaskutas

**Bill and Lee at Cliff House, San Francisco, Thanksgiving Day, 1985.**

grandmother and as a child did
not see much of his parents, who had separately moved to Southern California. After graduating from high school, Bill joined the navy, took a placement test, and was told he could have pretty much any job he wanted to train for. He chose to study radar technology and spent many months at navy schools on Treasure Island and also in Washington State. After his training he served in the Pacific on an aircraft carrier in the "CCC", the Command and Control Center, where he was their ace repairman. When not repairing the radar equipment, he played bridge, read, and taught himself how to play the jazz saxophone. (Bill played jazz piano too in his younger days.)

At the end of his three years of naval service, Bill took another placement test at the navy. Apparently he got the highest score that anyone had ever gotten. They asked him to stay in the navy and enter their training program for jet fighter pilots. He told me that had he done that, he would probably have become an astronaut (and now, he joked, would be an airline pilot!). He decided instead to leave the navy and try to go to college.

Bill went to Pasadena City College for two years, then took still another test, this one to compete for the two slots that are made available each year for transfers to Cal Tech. Again, his performance on the test was a big surprise to everyone, including the math professor who had to grade the math question. It seems the professor did not expect anyone to actually be able to solve the problem; he just wanted to see how they approached it. Bill solved the problem, was admitted to Cal Tech, and majored in mathematics, of course.

One day at the Naval Undersea Research Center, Bill got a call from his thesis advisor, Henry Dye, who told him to apply for the Benjamin Peirce Instructor job at Harvard. Bill was shocked. "Me?" he said. "Yes, you should apply, Bill," insisted Henry Dye. But Bill was ambivalent, in large part because the navy had paid for his education, and he felt that he owed them. He took the issue to his boss, also a PhD-level mathematician, who told him that it would be payback enough if Bill were to thrive as an academic mathematician, training other mathematicians, and doing original mathematics research. Bill's eyes would tear up when he told me that story, because he was so grateful and impressed by the generosity expressed by the man.

Bill joined the Berkeley mathematics department in 1968 as a lecturer, became an associate professor in 1969, and a Full Professor five years later. He retired in 2003 and continued doing mathematics research until his death in November 2011.

When Bill did his mathematics research he got excited about his discoveries and might write "WOW" in big letters, plus three exclamation points, and put a box around it. I only discovered this about Bill—that he was alone but not lonely doing his work—when I went through his papers to choose something handwritten for one of the collages for his memorial service.

### Family$_{Bill}$ = Mathematical Family

Bill was enormously proud of his students. He shared with me how he chose his students. He had two rules. They had to have demonstrated that they would be able to do deep, original mathematical research. But that is an obvious criterion. The second rule was that he had to *like* them, that they had to be nice, good people. He did not take on a new student lightly or thoughtlessly and felt it to be a lifelong commitment. Whenever possible, we would have the student over to dinner at our house when they were graduating. Bill looked forward to these dinners very much, and afterwards he loved hearing what I thought of the person, as it was often the first time we had met. I liked them all and loved some, as did he.

A memorial service honoring Bill was held on February 19, 2012, at the Berkeley Faculty Club. At the service we enjoyed French wine from Bill's wine cellar and listened to a local jazz band play some of his favorite tunes. Bill's students and colleagues shared their memories and stories about him.

Something I realized only after he was gone is that Bill had been a very happy, and always optimistic person. In closing, we should all remember that one of the many remarkable things about Bill is that he never expressed any regrets. He loved his life.

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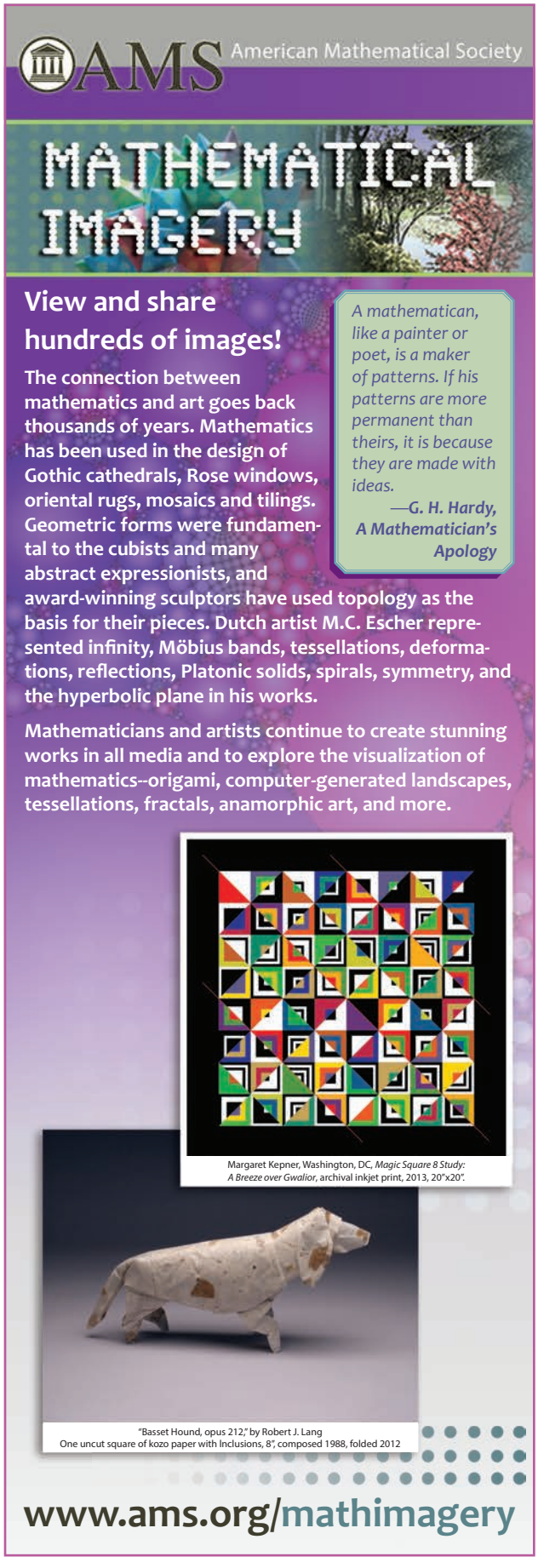

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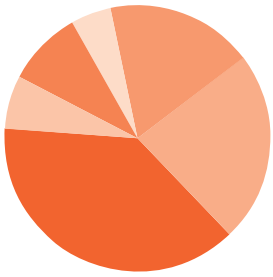


# Report on the 2013-2014 New Doctoral Recipients

*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, 2013 through June 30, 2014. Information in the report was provided by the departments that awarded the degrees with additional information provided by the individual new doctoral recipients. The report includes an analysis of the fall 2014 employment plans of 2013–2014 doctoral recipients and a demographic profile summarizing characteristics of citizenship status, gender, and racial/ethnic group. This report is based on a complete census of the 2013–2014 new doctorates and includes information about 2013–2014 doctoral recipients that were not included in the preliminary report in the March 2015 issue of *Notices*.

Detailed information, including tables which traditionally appeared in this report, is available on the AMS website at `www.ams.org/annual-survey/survey-reports`.

## Doctoral Degrees Awarded

1,926 PhDs were awarded by the 315 doctoral-granting departments. We are pleased to report that we had a 100% response rate for this survey, and we thank the departments for their cooperation.

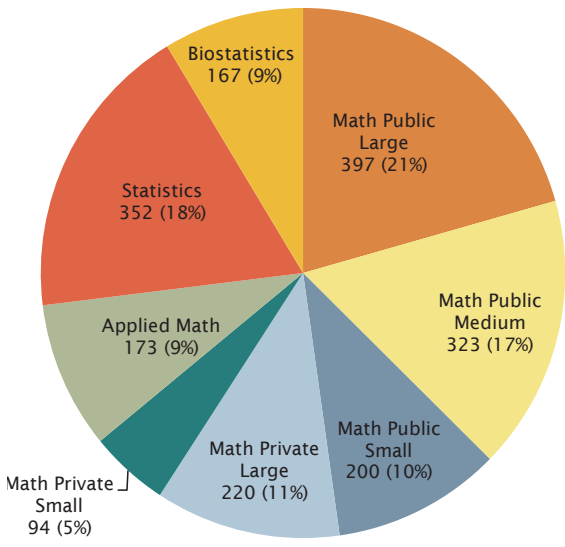
Math Public Medium reported the largest increase in the number of doctoral recipients, up 35 over the total of 288 reported for 2012–2013.

33% (629) of the new PhDs had a dissertation in statistics/biostatistics, followed by algebra/number theory with 16% (300) and applied mathematics with 12% (236).

Comparing PhDs awarded this year to last year, the number of PhDs awarded:

- Increased about 5% from 1,843 to 1,926.
- Increased in all groups except Math Public Large and Math Public Small.
- Increased 22% in Math Private Small.
- Decreased 9% in Math Public Small.

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



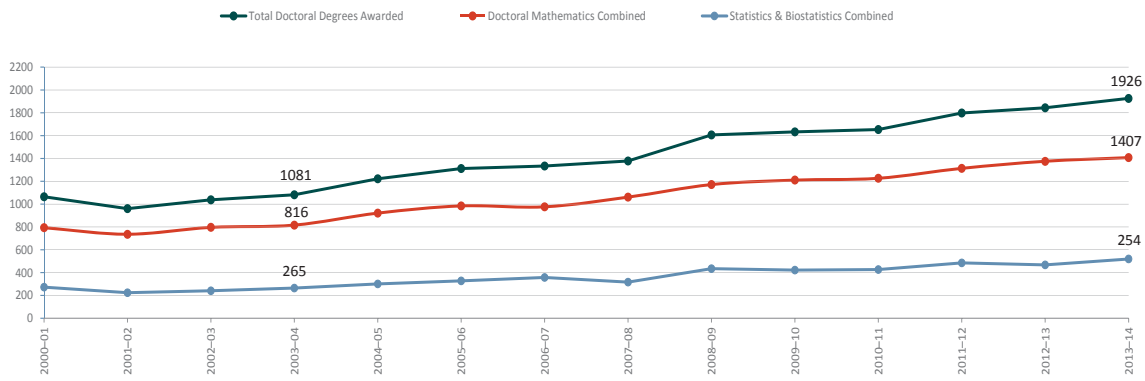

**Total Degrees Awarded: 1,926**

*See page 781 for a description of the department groupings.

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

# Doctoral Degrees Awarded

**Figure A.2: New PhDs Awarded by Group**



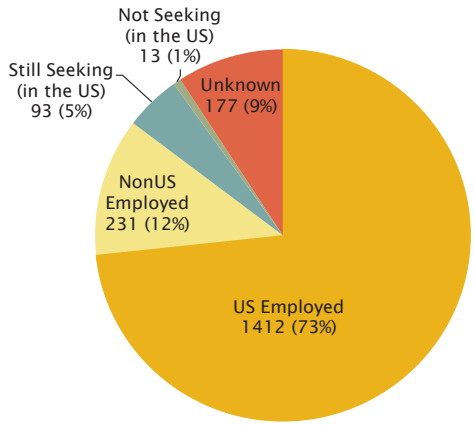

Comparing PhDs awarded this year with those awarded in 2003–2004:

- PhDs awarded have increased more than 78% over the last 10 years.
- Degrees awarded by Doctoral Mathematics combined and by Statistics & Biostatistics combined have increased 72% and 96%, respectively. Some of this latter increase is due to the increase in response rate among the Statistics & Biostatistics departments and an increase in the number of biostatistics programs included in the Annual Survey over the last 3 years.

# Employment

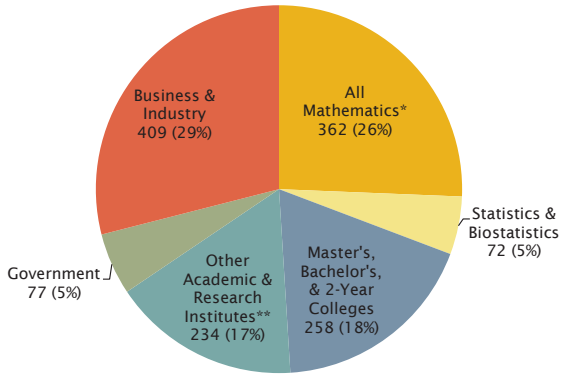
The overall US unemployment rate for the new doctoral recipients is 6.2%, up from 5.7% last year. (Details on the calculations are on page 781.) The employment plans are known for 1,749 of the 1,926 new doctoral recipients. The number of new doctoral recipients employed in the US is 1,412, up 6% from last year's number of 1,334. 71% of PhDs employed in Doctoral Math departments are in postdoc positions, up from 69% last year. The number of new PhDs taking positions in Business & Industry has increased to 409 this year compared to 381 last year. All groups except Math Public Large and Biostatistics showed an increase in Business & Industry, and 61% of the increase was accounted for by the Statistics Group.

**Figure E.1: Employment Status**




- 53% (755) of those who are employed in the US are US citizens, up slightly from 52% last year.
- 75% (657) of non-US citizens whose employment status is known are employed in the US, the remaining 222 non-US citizens are either employed outside of the US or are unemployed.
- 8% (126) of the new PhDs who are employed are working at the institution which granted their degree, up from 6% last year. These individuals constitute 14% of total US academic employed.
- 63% of those still seeking employment in the US are US citizens.

**Figure E.2: US Employed by Type of Employer**

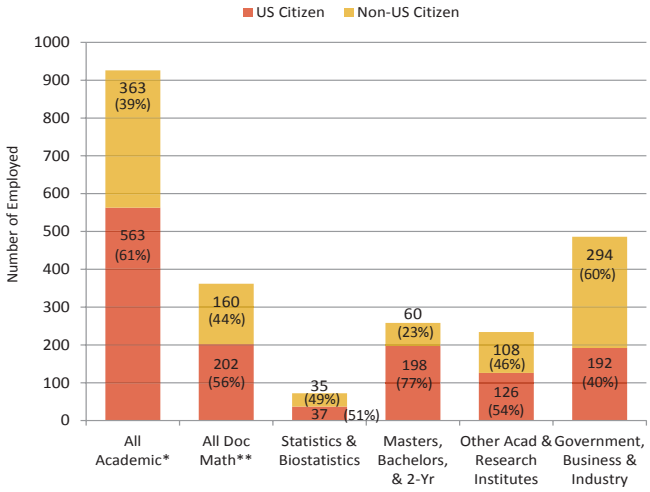



*Includes all Math Public, Math Private, and Applied Math departments.
**Other Academic consists of departments outside the mathematical sciences including numerous medical-related units.

- US academic hiring increased 5% to 926 compared to 878 last year.
- Goverment hiring increased 3% (from 75 to 77); all doctoral-granting groups except Math Public Large, Math Public Small, Math Private Large, and Biostatistics showed an increase in the number of PhDs taking positions in this sector.

# Employment

**Figure E.3: Employment in the US by Type of Employer and Citizenship Total: 1,412**

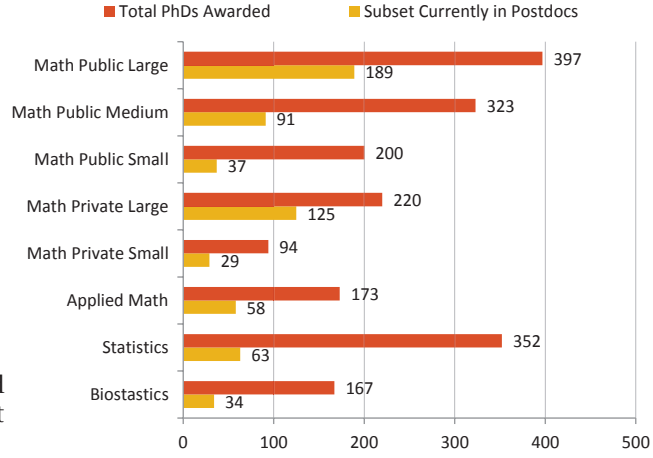



* Includes all Math sciences departments plus other academic and research institutes/nonprofit.
**Includes all Math Public, Math Private, and Applied Math departments.

Of the US citizens whose employment status is known, 87% (755) are employed in the US, and of these:

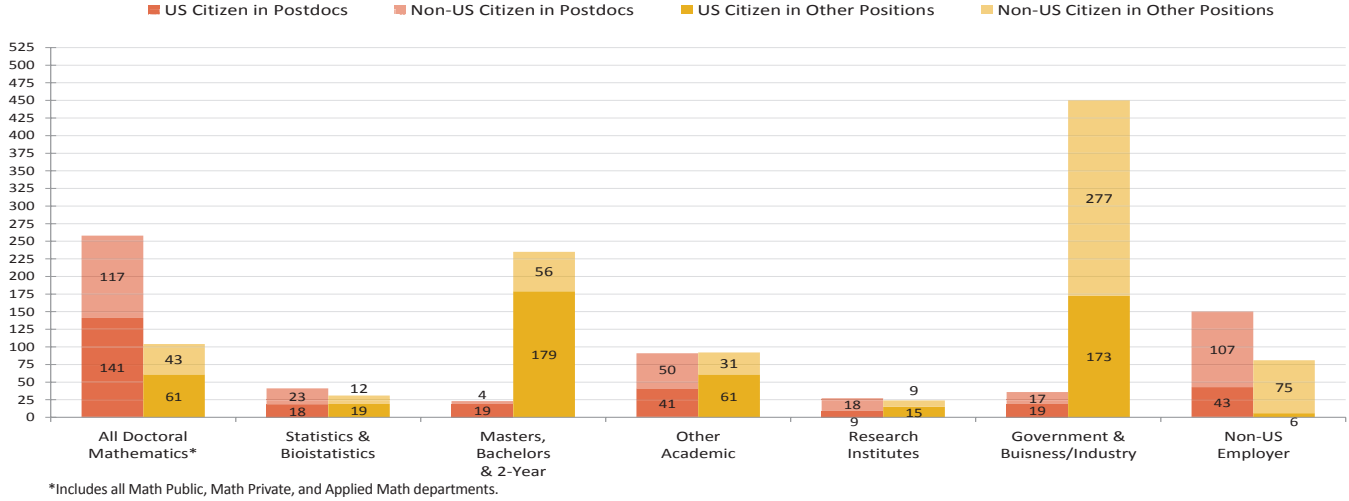
- 32% are employed in PhD-granting departments
- 43% are employed in all other academic categories
- 25% are employed in government, business and industry

**Figure E.4: PhDs Employed in Postdocs by Degree-Granting Department Group**




- Total known to be employed: 1,643
- 38% (626) of the new PhDs that are employed are reported to be in postdoc positions, the same percentage as last year but up in number from 600.
- 57% of the new PhDs awarded by the Math Private Large group are employed in postdocs, while only 19% of new PhDs awarded by the Math Public Small group and 18% of PhDs awarded by the Statistics group are in postdocs.
- 48% of the new PhDs having US academic employment are in postdocs, up from 46% last year.

**Figure E.5: New PhDs Employment by Citizenship, Type of Position and Type of Employer**




*Includes all Math Public, Math Private, and Applied Math departments.

- 24% of the new PhDs in postdoc positions are employed outside the US; last year, this percentage was 27%.
- 93% of the new PhDs employed in the Math Private Large Group are in postdoc positions, up from 92% last year.
- 71% of the new PhDs employed in Doctoral Math departments are in postdoc positions, up from 69% last year.

# Employment

Figure E.6 displays the US unemployment rate for new doctorates; details on the calculations are on page 781.

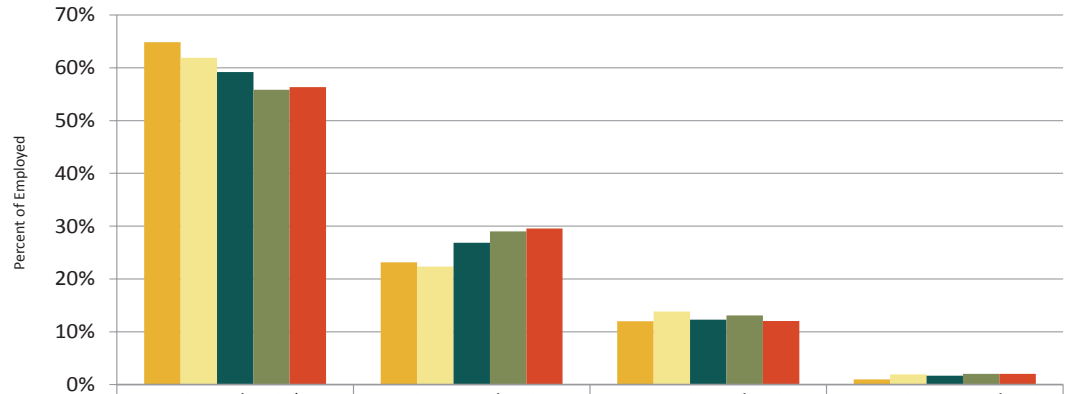
**Figure E.6: Percentage of New Doctoral Recipents Unemployed 2004–2013***

*The difficult employment years of the 1990s are not shown here but are located on the AMS website at www.ams.org/annual-survey/2014Survey-NewDoctorates-Report.

Among new doctorates reported to be in the US:

- Unemployment among those whose employment status is known is 6.2%, up from 5.7% for Fall 2013.
- 7.2% of US citizens are unemployed, compared to 6.5% in Fall 2013.
- 4.9% of non-US citizens are unemployed, compared to 4.7% in Fall 2013.
- New doctorates from the Math Public Small Group reported the highest unemployment rate at 12.0%, up from 8.9% last year.
- New doctorates from the Biostatistics Group reported the lowest unemployment at 1.8%.

**Figure E.7: Percentage of Employed New PhDs by Type of Employer**




| | US Academic* | US Noncademic | Non-US Academic | Non-US Nonacademic |
|---|---|---|---|---|
| Fall 2010 | 65% | 23% | 12% | 1% |
| Fall 2011 | 62% | 22% | 14% | 2% |
| Fall 2012 | 59% | 27% | 12% | 2% |
| Fall 2013 | 56% | 29% | 13% | 2% |
| Fall 2014 | 56% | 30% | 12% | 2% |

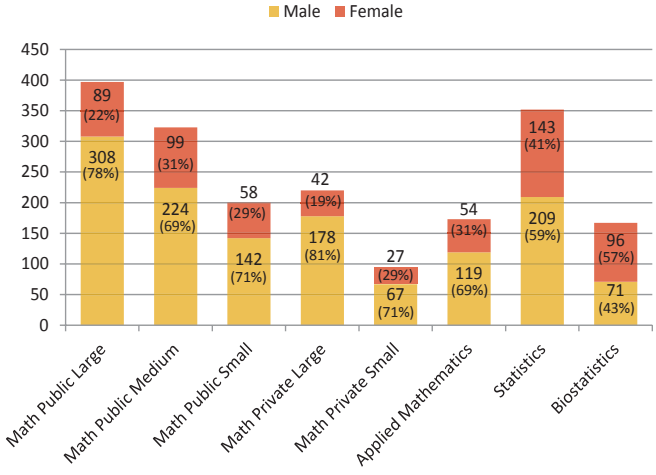
* Includes other academic departments and research institutes/other non-profits.

- US academic hiring has remained at 56%, while US nonacademic hiring has jumped to 30% (a five-year high).
- Detailed information on new PhDs employed in the US by degree-granting department group is available on the AMS website at www.ams.org/annual-survey/2014Survey-NewDoctorates-Report.

# Demographics

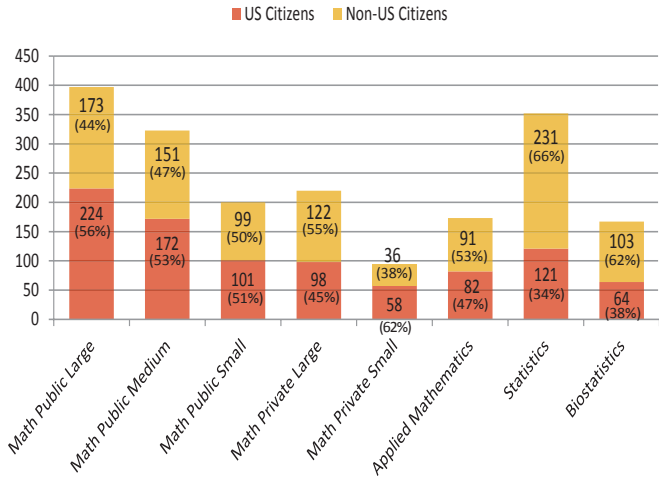
Gender and citizenship was known for all 1,926 new PhDs reported for 2013–2014. The number of US citizens is 920 (48%), up slightly from 47% last year. Females accounted for 28% of the US citizen total (up from 27% last year). Non-US citizens receiving a PhD decreased to 52% from 53% last year. 11% (70) of the non-US citizens employed in the US have permanent visa status (down from 13% last year).

**Figure D.1: Gender of Doctoral Recipients by Degree-Granting Grouping**



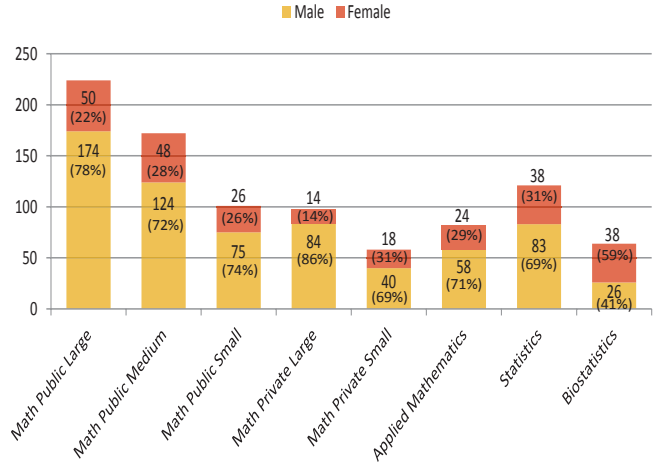

- Females account for 32% (608) of 1,926 PhDs, up from 31% last year.

**Figure D.2: Citizenship of Doctoral Recipients by Degree-Granting Grouping**



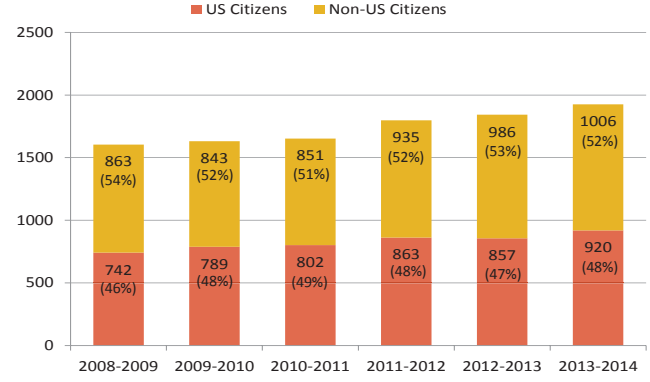

- 61% of all the PhDs awarded by the Math Private Small group were to US citizens, while only 34% of the PhDs awarded by the Statistics group were to US citizens.

**Figure D.3: Gender of US Citizen Doctoral Recipients by Degree-Granting Grouping**




- 50% of the males and 42% of the females are US citizens.
- Females accounted for 28% of the US citizens.
- Among the US citizens: 7 are American Indian or Alaska Native, 61 are Asian, 25 are Black or African American, 29 are Hispanic or Latino, 4 are Native Hawaiian or Other Pacific Islander, 762 are White, and 32 are of unknown race/ethnicity.
- Math Public Large awarded the highest number (16) of PhDs to US citizen minorities, while Biostatistics awarded the smallest number (3), followed by Math Public Small and Math Public Large with 4 each.

**Figure D.4: Citizenship of New PhD* Recipients, 2007–2013**




*The increase shown from 2007–2008 to 2008–2009 is due in part to the increase in the response rate for statistics and biostatistics departments.

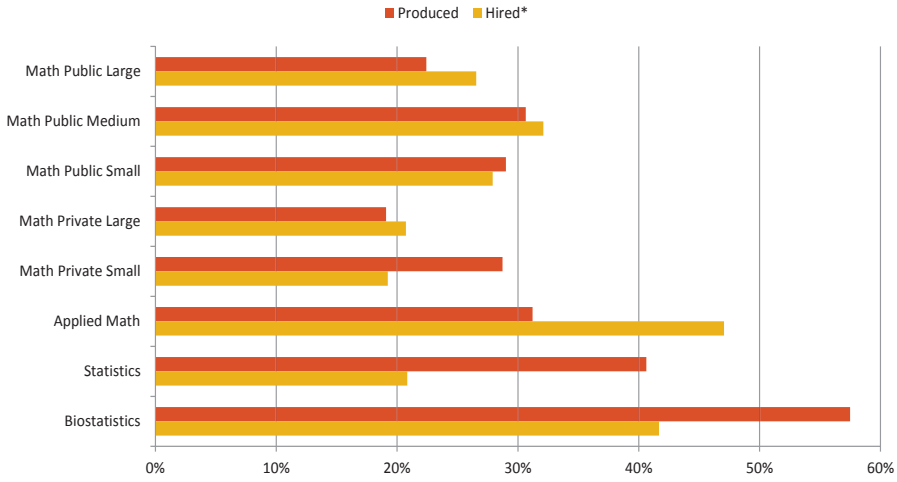
Looking at the last six years we see that:

- US citizen counts, which had been increasing steadily, increased to 920 this year. While this is a 7% increase from last year, it is a 24% increase from Fall 2008–2009.
- Non-US citizen counts have increased for the fourth consecutive year to 1,006. While this is a 17% increase from Fall 2008–2009, it represents a 2% increase from last year.

# Female New Doctoral Recipients

After remaining at 31% for the last few years, the proportion of female new doctoral recipients increased to 32% this year. Of the 926 new PhDs hired into academic positions, 32% (300) were women, the same percentage as last year. 25% of those hired into postdoc positions were women, with 43% of the women in postdocs being US citizens, up from 39% last year. The US unemployment rate for females is 4.6%, compared to 6.9% for males and 6.2% overall.

**Figure F.1: Females as a Percentage of New Doctoral Recipients Produced by and Hired by Department Grouping**



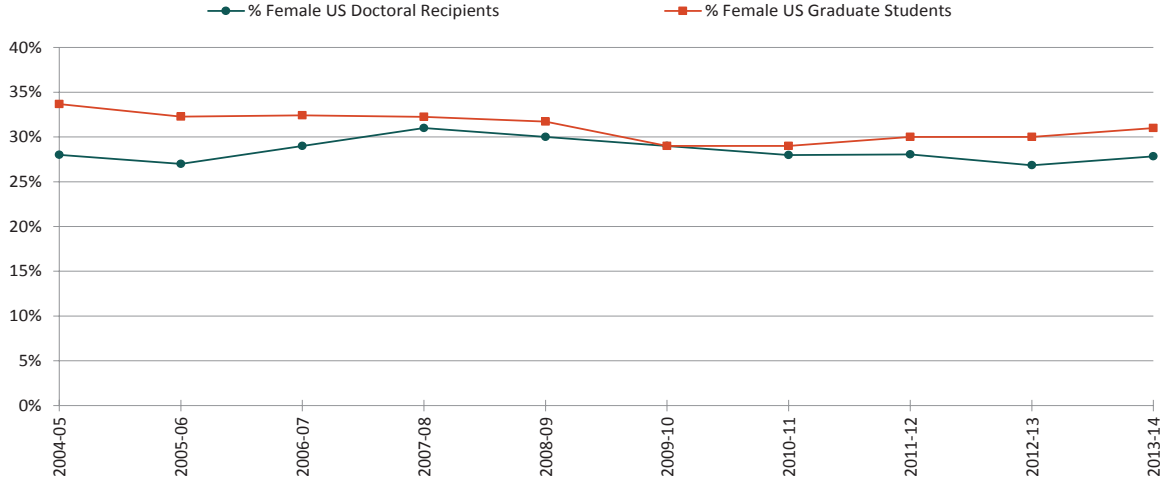

* Females as a percentage of total hires by the department grouping.

**Table F.1: Number of Female New Doctoral Recipients Produced by and Hired by Department Groupings**

| Department Grouping | Females Produced | Females Hired |
|---|---|---|
| Math Public Large | 89 | 30 |
| Math Public Medium | 99 | 26 |
| Math Public Small | 58 | 12 |
| Math Private Large | 42 | 17 |
| Math Private Small | 27 | 5 |
| Applied Math | 54 | 8 |
| Statistics | 143 | 10 |
| Biostatistics | 96 | 10 |
| **Total** | **608** | **118** |

- 44% of those hired by the Bachelors Group were women (up from 36% last year) and 34% of those hired by the Masters Group were women (up from 31% last year).
- 33% of those hired into Research Institutes/Other non-profit positions were women (down from 46% last year).
- 34% of those hired into Government positions were women (up from 32% last year).
- 64% of the women employed in all doctoral groups are in postdoc positions, compared to 71% of males employed in these groups.

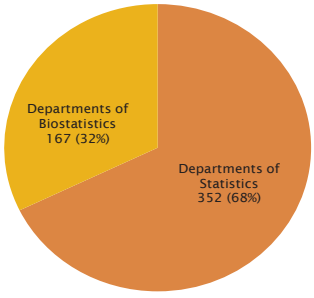
**Figure F.2: Females as a Percentage of US Citizen Doctoral Recipients**



# PhDs Awarded by Statistics and Biostatistics Departments

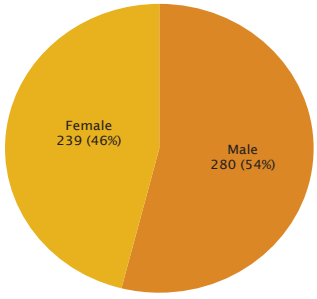
This section contains information about new doctoral recipients in these departments (58 statistics and 44 biostatistics departments). Statistics and Biostatistics departments produced 519 new doctorates, of which all had dissertations in statistics/biostatistics. This is an 11% increase in the number reported for fall 2013, which was 468. In addition, Math Public, Math Private and Applied Math departments combined had 115 PhD recipients with dissertations in statistics. 36% (185) of the new PhDs awarded by Statistics and Biostatistics departments are US citizens (while in the other groups combined, 52% are US citizens). The US unemployment among this group of new PhDs is 2.5%, up from 2.1%.

**Figure S.1: PhDs Awarded by Statistics/Biostatistics Departments**



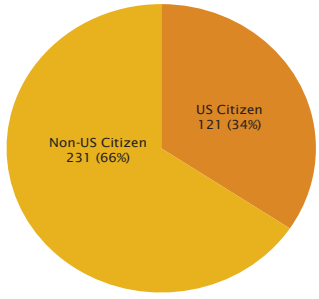

- 27% of all PhDs awarded were in Statistics/Biostatistics.
- Females account for 41% of statistics and 57% of biostatistics PhDs awarded.

**Figure S.2: Gender of PhD Recipients from Statistics/Biostatistics Departments**



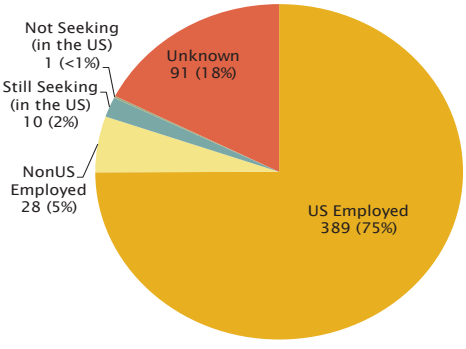

- Females accounted for 47% of the 519 PhDs in Statistics and Biostatistics, compared to all other groups combined, where 26% are female.

**Figure S.3: Citizenship of PhD Recipients from Statistics/Biostatistics Departments**




- 41% of Statistics/Biostatistics US citizen PhD recipients are females, while in all other groups combined 25% of the US citizens are females.

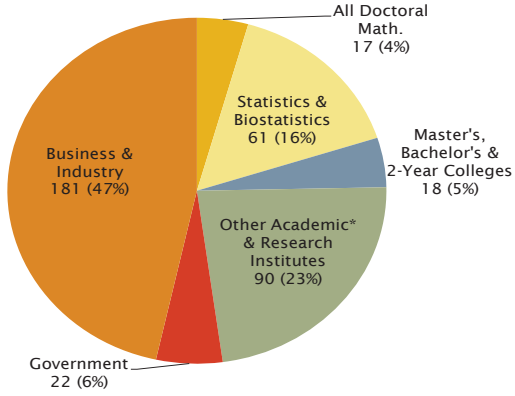
**Figure S.4: Employment Status of PhD Recipients from Statistics/Biostatistics Departments**




**Total PhDs Awarded: 519**

- 2.5% of Statistics/Biostatistics PhDs are unemployed compared to 6.9% among all other groups. This is up from 2.1% last year.
- Unemployment among new PhDs with dissertations in statistics/probability is 3.7%, up from 3.1%. Among all other dissertation groupings, 6.0% are unemployed.

**Figure S.5: US-Employed PhD Recipients from Statistics/Biostatistics Departments by Type of Employer**




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

**Total US Employed: 389**

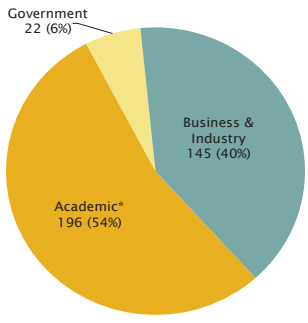
- 47% of Statistics/Biostatistics PhDs are employed in Business/Industry, compared to 25% in all other groups.
- 28% of those hired by statistics and biostatistics were females, the same percentage as that in all other groups.

# Information from the Employment Experiences of New Doctorates (EENDR) Survey

This section contains additional information on employment gathered from a subset of the 2013–2014 new PhDs on the EENDR Survey. It expands on the details of employment which are not available through the departments.

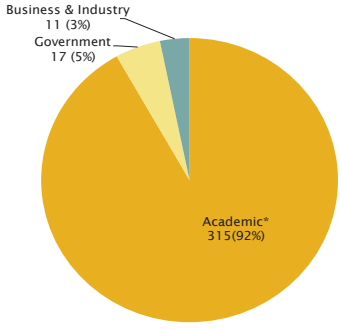
The EENDR survey was sent to the 1,702 new PhDs for which departments provided current contact information by early October of 2014. Of these individuals, 821 (48%) responded. The employment status is known for 851 of these individuals; the US unemployment among this group is 1.7%. Of the 796 who reported being employed, 30% indicated they were actively looking for new employment.

**Figure EE.1: EENDR Respondents Reporting Permanent US Employment by Sector**



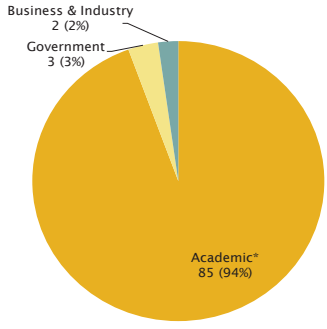

* Includes research institutes and other non-profits.

**Figure EE.2: EENDR Respondents Reporting Temporary US Employment by Sector**




* Includes research institutes and other non-profits.

**Figure EE.3. EENDR Respondents Employed Outside the US by Sector**




* Includes research institutes and other non-profits.

Of the 363 permanently employed:

- 34% are women.
- 71% of those reporting academic employment hold tenured/ tenure-track positions.

Of the 343 temporarily employed:

- 31% are women.
- 43% were unable to find a suitable permanent position (down from 52% last year).
- 76% are employed in postdocs and 34% of these reported they could not find a suitable permanent position.

Of the 90 employed outside the US:

- 18% are women.
- 32% are US Citizens.
- 80% are employed in postdocs.

**Table EE.1: Number and Percentage of EENDR Respondents Employed in the US by Job Status**

| | | | | | Temporary | | Temporary Postdocs | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Perm Total | % | Temp Total | % | Perm Not Avail | % of Temp Total | Total | % of Temp Total | Perm Not Avail | % of Temp Postdocs | #(%) Unknown |
| Fall 2010 | 320 | 48% | 341 | 52% | 140 | 41% | 246 | 72% | 68 | 28% | 0% |
| Fall 2011 | 251 | 44% | 319 | 56% | 133 | 42% | 225 | 71% | 87 | 39% | 0 |
| Fall 2012 | 261 | 44% | 328 | 56% | 127 | 39% | 242 | 74% | 108 | 45% | 0 |
| Fall 2013 | 374 | 53% | 335 | 47% | 173 | 52% | 247 | 74% | 106 | 43% | 0 |
| Fall 2014 | 363 | 51% | 343 | 49% | 148 | 43% | 260 | 76% | 88 | 34% | 0 |

Comparing the employment status of EENDR respondents employed in the US over the last five years, we see that:

- Permanent positions have decreased to 51% this year, from last year's five-year high of 53%.
- Temporary positions increased to 49% this year.
- 43% of those holding temporary positions were unable to find suitable permanent positions, down from last year's five-year high of 52%.
- 34% of those holding postdoc positions were unable to find suitable permanent positions, down four percentage points from last year and up 6 percentage points from the five-year low of 28% for fall 2010.

# Information from the Employment Experiences of New Doctorates (EENDR) Survey

**Table EE.2: Percentage of EENDR Respondents Employed in the US by Employment Sector within Job Status**

| Year | Permanent | | | Temporary | | |
|---|---|---|---|---|---|---|
| | Acad | Govn | B/I | Acad | Govn | B/I |
| Fall 2010 | 64% | 8% | 28% | 93% | 5% | 2% |
| Fall 2011 | 61% | 8% | 31% | 94% | 5% | 1% |
| Fall 2012 | 61% | 8% | 32% | 92% | 5% | 2% |
| Fall 2013 | 53% | 7% | 40% | 92% | 4% | 4% |
| Fall 2014 | 54% | 6% | 40% | 92% | 5% | 3% |

Looking at Table EE.2, we see that

- Permanent academic employment has increased to 54%, while temporary employment in this sector has leveled off at 92%.
- Permanent and temporary government employment has dropped to 6%, while temporary positions increased to 50%.
- Business/Industry permanent employment remains stable at 40% (a five-year high), while temporary positions decreased to 3%.

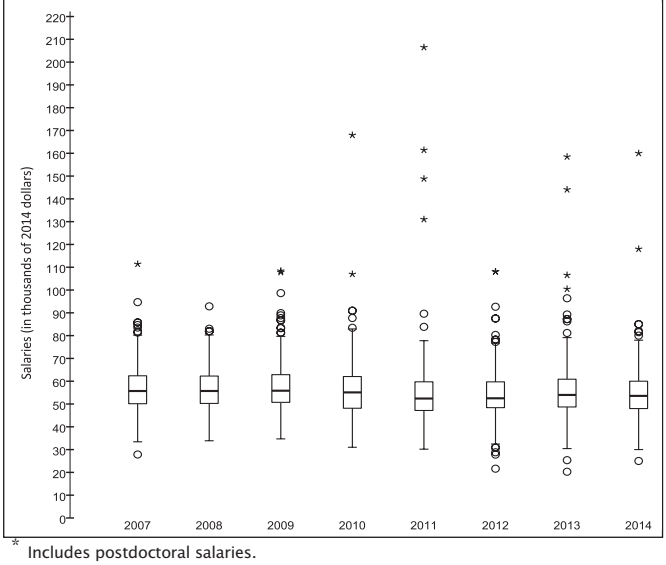
# Starting Salaries of the 2013–2014 Doctoral Recipients

The starting salary figures were compiled from information gathered on the EENDR questionnaires sent to 1,702 individuals using addresses provided by the departments granting the degrees; 821 individuals responded between late October and April. Responses with insufficient data or from individuals who indicated they had part-time or non-US employment were excluded. Numbers of usable responses for each salary category are reported in the following tables.

Readers should be warned that the data in this report are obtained from a self-selected sample, and inferences from them may not be representative of the full population. Detailed information, including boxplots which traditionally appeared in this report, is available on the AMS website at `www.ams.org/annual-survey/survey-reports`.

**Academic Teaching/Teaching and Research 9–10-Month Starting Salaries* (in thousands of dollars)**

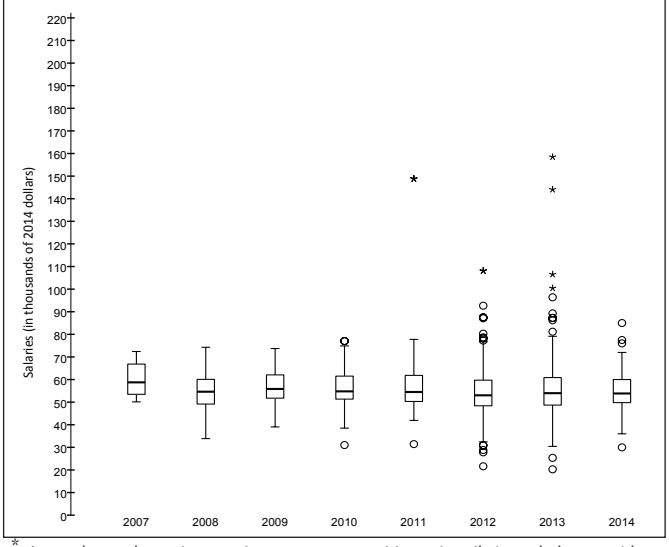
| PhD Year | Min | $Q_1$ | Median | $Q_3$ | Max |
|---|---|---|---|---|---|
| Total (187 male/108 female) | | | 53.0** | | |
| 2014 M | 36.0 | 48.0 | ~~73.0~~ | 60.0 | 160.0 |
| 2014 F | 25.0 | 50.0 | 54.8 | 60.0 | 85.0 |
| One year or less experience (151 male/97 female) | | | | | |
| 2014 M | 36.0 | 48.0 | 53.0 | 60.0 | 160.0 |
| 2014 F | 25.0 | 50.0 | 54.0 | 60.0 | 85.0 |




* Includes postdoctoral salaries.

**Academic Postdoctorates Only* 9–10-Month Starting Salaries (in thousands of dollars)**

| PhD Year | Min | $Q_1$ | Median | $Q_3$ | Max |
|---|---|---|---|---|---|
| Total (69 male/34 female) | | | | | |
| 2014 M | 40.0 | 50.0 | 55.0 | 60.0 | 76.0 |
| 2014 F | 30.0 | 46.0 | 51.5 | 55.0 | 85.0 |
| One year or less experience (69 male/34 female) | | | | | |
| 2014 M | 40.0 | 50.0 | 55.0 | 60.0 | 76.0 |
| 2014 F | 30.0 | 46.0 | 51.5 | 55.0 | 85.0 |



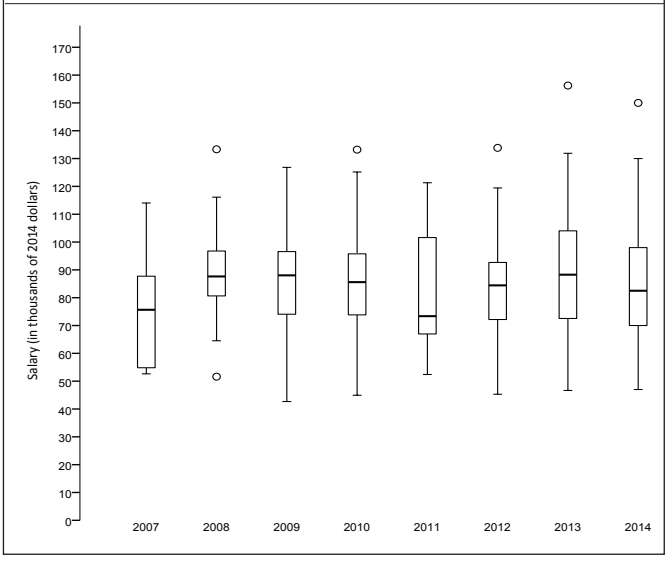

* A postdoctoral appointment is a temporary position primarily intended to provide an opportunity to extend graduate training or to further research experience.

** Note: The published report incorrectly cited this as 73.0.

# Starting Salaries of the 2013–2014 Doctoral Recipients

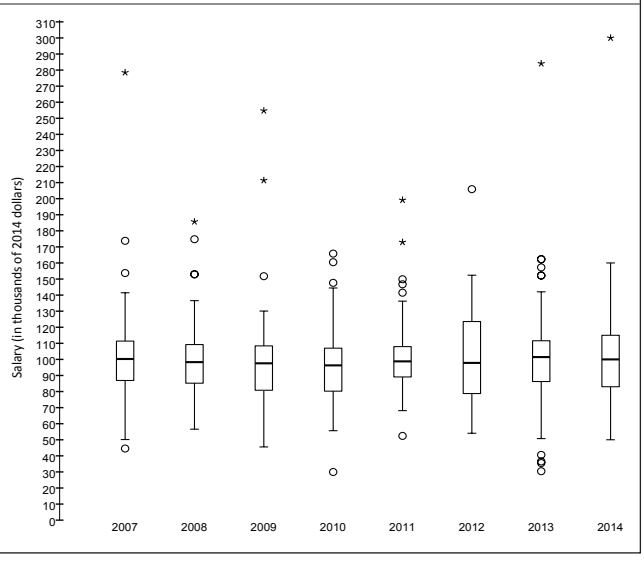
**Government**
**11–12-Month Starting Salaries**
**(in thousands of dollars)**

| PhD Year | Min | $Q_1$ | Median | $Q_3$ | Max |
|---|---|---|---|---|---|
| Total (28 male/10 female) | | | | | |
| 2014 M | 60.0 | 75.0 | 88.2 | 99.0 | 150.0 |
| 2014 F | 47.0 | 58.0 | 70.0 | 84.9 | 105.0 |
| One year or less experience (24 male/10 female) | | | | | |
| 2014 M | 60.0 | 75.0 | 87.1 | 96.8 | 130.0 |
| 2014 F | 47.0 | 61.6 | 70.0 | 88.8 | 105.0 |




**Business and Industry**
**11–12-Month Starting Salaries**
**(in thousands of dollars)**

| PhD Year | Min | $Q_1$ | Median | $Q_3$ | Max |
|---|---|---|---|---|---|
| Total (108 male/39 female) | | | | | |
| 2014 M | 56.0 | 86.2 | 100.0 | 120.0 | 300.0 |
| 2014 F | 50.0 | 80.0 | 91.0 | 101.0 | 140.0 |
| One year or less experience (93 male/35 female) | | | | | |
| 2014 M | 56.0 | 85.5 | 100.0 | 120.0 | 300.0 |
| 2014 F | 50.0 | 79.5 | 86.0 | 101.0 | 140.0 |




# Remarks on Starting Salaries

*Key to Tables and Graphs.* Salaries are those reported for the fall immediately following the survey cycle. Years listed denote the survey cycle in which the doctorate was received—for example, survey cycle July 1, 2013–June 30, 2014 is designated as 2014. Salaries reported as 9–10 months exclude stipends for summer grants or summer teaching or the equivalent. M and F are male and female, respectively. Male and female figures are not provided when the number of salaries available for analysis in a particular category was five or fewer. All categories of "Teaching/Teaching and Research" and "Research Only" contain those recipients employed at academic institutions only.

*Graphs.* The graphs show standard boxplots summarizing salary distribution information for the years 2007 through 2014. Values plotted for 2007 through 2014 are converted to 2014 dollars using the implicit price deflator prepared annually by the Bureau of Economic Analysis, US Department of Commerce. These categories are based on work activities reported in EENDR. Salaries of postdoctorates are shown separately. They are also included in other academic categories with matching work activities.

For each boxplot the box shows the first quartile (Q1), the median (M), and the third quartile (Q3). The interquartile range (IQR) is defined as Q3–Q1. Think of constructing invisible fences 1.5 IQR below Q1 and 1.5 IQR above Q3. Whiskers are drawn from Q3 to the largest observation that falls below the upper invisible fence and from Q1 to the smallest observation that falls above the lower invisible fence. Think of constructing two more invisible fences, each falling 1.5 IQR above or below the existing invisible fences. Any observation that falls between the fences on each end of the boxplots is called an outlier and is plotted as ○ in the boxplots. Any observation that falls outside of both fences either above or below the box in the boxplot is called an extreme outlier and is marked as ✱ in the boxplot.

## Remarks on US Unemployment Rate Calculations

In the unemployment calculations provided in this report, the individuals employed outside the US have been removed from the denominator used in the calculation of the rate, in addition to the routine removal of all individuals whose employment status is unknown. This is a change from Annual Survey Reports prior to 2009. As a consequence, the unemployment rate now being reported more accurately reflects the US labor market experienced by the new doctoral recipients. This change tends to increase the rate of unemployment over that reported in prior years.

In a further small change from prior years, those individuals reported as not seeking employment have also been removed from the denominator. The number of individuals so designated is small each year, and the impact of this change is to produce a slight increase in the rate over that reported in prior years.

The unemployment rates for years prior to 2009 shown in this report have been recalculated using this new method. One can view a comparison of the unemployment rates using the traditional method and the new method by visiting the AMS website at `www.ams.org/annual-survey/surveyreports.html`.

## Departmental Groupings and Response Rates

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 PhDs awarded between 2000 and 2010, based on their reports to the Annual Survey during this period. Furthermore, doctorate-granting departments which self-classify their PhD 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 `www.ams.org/notices/201209/rtx120901262p.pdf`.

### Group Descriptions

**Math Public Large** consists of departments with the highest annual rate of production of PhDs ranging between 7.0 and 24.2 per year.

**Math Public Medium** consists of departments with an annual rate of production of PhDs ranging between 3.9 and 6.9 per year.

**Math Public Small** consists of departments with an annual rate of production of PhDs of 3.8 or less per year.

**Math Private Large** consists of departments with an annual rate of production of PhDs ranging between 3.9 and 19.8 per year.

**Math Private Small** consists of departments with an annual rate of production of PhDs of 3.8 or less per year.

**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 US departments granting a Master's degree as the highest graduate degree.

**Group B** contains US departments granting a baccalaureate degree only.

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

### Survey Response Rates by New Groupings

**Doctorates Granted**
**Departmental Response Rates***

| | | |
|---|---|---|
| **Math Public Large** | 26 of 26 including | 0 with no degrees |
| **Math Public Medium** | 40 of 40 including | 0 with no degrees |
| **Math Public Small** | 64 of 64 including | 8 with no degrees |
| **Math Private Large** | 24 of 24 including | 0 with no degrees |
| **Math Private Small** | 28 of 28 including | 4 with no degrees |
| **Applied Math** | 31 of 31 including | 2 with no degrees |
| **Statistics** | 58 of 58 including | 1 with no degrees |
| **Biostatistics** | 44 of 44 including | 13 with no degrees |
| **Total** | 315 of 315 including | 28 with no degrees |

*FROM THE AMS SECRETARY*

ATTENTION ALL AMS MEMBERS

# Voting Information for 2015 AMS Election

AMS members who have chosen to vote online will receive an email message on or shortly after August 17, 2015, from the AMS Election Coordinator, Survey & Ballot Systems.

The From Line will be "AMS Election Coordinator", the Sender email address will be noreply@directvote.net, and the Subject Line will be "AMS 2015 Election—login information below". If you use a spam filter you may want to use the above address or subject information to configure your spam filter to ensure this email will be delivered to you.

The body of the message will provide your unique voting login information and the address (URL) of the voting website.

AMS members who have chosen to vote by paper should expect to receive their ballot by the middle of September. Unique voting login information will be printed on the ballot, should you wish to vote online.

At midnight (US Eastern Time) on November 6, 2015, the website will stop accepting votes. Paper ballots received after this date will not be counted.

Additional information regarding the 2015 AMS Election is available on the AMS website: www.ams.org/election-info
or by contacting the AMS: election@ams.org, 800-321-4267 (US & Canada), 401-455-4000 (worldwide).

Thank you and . . . please remember to vote.

Carla D. Savage

AMS
American Mathematical Society
www.ams.org

# Doctoral Degrees Conferred

*2013–2014*

## ALABAMA

### Auburn University (12)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Asplund, John*, 5-cycle systems

*Denhere, Melody*, Robust statistical methods for the functional logistic model

*Harmon, Henry*, Some geometry of symmetrized tensor spaces

*He, Xin*, Lebesgue approximation of superprocesses

*Hughes, Glenn*, Completeness properties in function spaces with the compact-open topology

*Indika, Koditthuwakku Arachchige Avantha*, Orthogonal bases of certain symmetry classes of tensors associated with Brauer characters

*Jones, Cadavious*, Security and secure-dominating sets in graphs

*Kong, Liang*, Spatial spread dynamics of monostable equations in locally inhomogeneous habitats

*Miakonkana, Guy-vanie Marcias*, Nonparametric rank based inferences for generalized linear models, longitudinal data analysis, and variable selection

*Mijena, Jebessa*, Space-time fractional Cauchy problems and trace estimates for relativistic stable processes

*Sawant, Pallavi*, Robust methods for multivariate functional data analysis

*Sturm, Frank*, Pseudo-solenoids are not continuously homogeneous

### University of Alabama (6)

DEPARTMENT OF MATHEMATICS

*Acharyya, Amrita*, Coverings of profinite graphs

*Chen, Qiang*, Calculus of variations and optimal control

*DarAssi, Mahmoud*, Investigation of the heat and mass transfer in a liquid suspension of small particles

*Das, Bikash*, Cofinite graphs and their profinite completions

*Maxwell, Mary*, Using Bayesian techniques with item response theory to analyze mathematics tests

*Schweiger, Adam*, Gravity, surfactants, and instabilities of two-layer shear flaws

### University of Alabama at Birmingham (9)

DEPARTMENT OF BIOSTATISTICS

*Mehta, Tapan*, The apparent change in obesity-mortality associations: Methodological issues in survival analyses with censored outcomes

*Seals, Samantha*, Spatial analysis of cardiovascular MRI data

*Wu, Guodong*, Quantification and association analysis for next-generation sequencing data

*Yan, Qi*, Statistical methods for set-based association tests in genetic studies

DEPARTMENT OF MATHEMATICS

*Chapman, Jacob*, Spectral properties of random block operators

*Korepanov, Alexey*, Small perturbations in hard balls dynamics

*Mahato, Ajay*, The inverse volatility problem for American options

*Ptacek, Ross*, Laminations and the dynamics of iterated cubic polynomials

*Wyatt, Mitchell*, Uniqueness of potential in Schrödinger's equation with one boundary measurement

### University of Alabama-Tuscaloosa (1)

INFORMATION SYSTEMS STATISTICS AND MANAGEMENT SCIENCE DEPARTMENT

*Xu, Jie*, Three essays on improving ensemble models

## ARIZONA

### Arizona State University (14)

SCHOOL OF HUMAN EVOLUTION AND SOCIAL CHANGE

*Cruz-Aponte, Maytee*, Epidemic dynamics of metapopulation models

*Luli, Dori*, A neuronal network model of Drosophila antennal lobe

*Morales-Butler, Emmanuel*, Applications of nonlinear systems of ordinary differential equations and Volterra integral equations to infectious disease epidemiology

*Patterson-Lomba, Oscar*, On the dynamics of infectious diseases in modern landscapes: Urban settings and drug resistance

SCHOOL OF MATHEMATICAL AND STATISTICAL SCIENCES

*Bowling, Stacey*, Conceptions of function composition in college precalculus students

*Elledge, Shawn*, On minimal levels of Iwasawa towers

*Halani, Aviva*, Students' ways of thinking about combinatorics solution sets

*Ismay, Chester*, Testing independence of parallel pseudorandom number streams: Incorporating the data's multivariate nature

*Jin, Wen*, Persistence of discrete dynamical systems in infinite dimensional state spaces

*Liu, Hao*, Spatial spread of rabies in wildlife

*Molla, Theodore*, On tiling directed graphs with cycles and tournaments

*Valdivia, Arturo*, Alternative methods via random forest to identify interactions in a general framework and variable importance in the context of value-added models

*Young, Jonathan*, Dependent models of signal transduction networks

The above list contains the names and thesis titles of recipients of doctoral degrees in the mathematical sciences (July 1, 2013, to June 30, 2014) reported in the 2015 Annual Survey of the Mathematical Sciences by 197 departments in 143 universities in the United States. Each entry contains the name of the recipient and the thesis title. The number in parentheses following the name of the university is the number of degrees listed for that university.

*Zhang, Jun*, A continuous latent factor model for non-ignorable missing data in longitudinal studies

## University of Arizona (18)

DEPARTMENT OF MATHEMATICS

*Gilbert, Michael*, Investigating the relationship between restriction measures and self-avoiding walks

*Herrera-Valdez, Marco*, Geometry and non-linear dynamics underlying excitability phenotypes in biophysical models of membrane potential

*Islambekov, Umar*, Lieb-Robinson bounds for the Toda lattice

*Leslie, Martin*, Hypermap-homology quantum codes

*Thomas, Matthew*, Analyzing conceptual gains in introductory calculus with interactively-engaged teaching styles

PROGRAM IN APPLIED MATHEMATICS

*Bailey, Brenae*, Stochastic models of $-1$ programmed ribosomal frameshifting

*Comeau, Darin*, Conceptual and numerical modeling of ice in a global climate framework

*Dinius, Joseph*, Dynamical properties of a generalized collision rule for multi-particle systems

*Hariprasad, Daniel*, Dynamics and lateral migration of red blood cells in Stokes flow

*Hyman, Jeffrey*, Heterogeneities and structures of flow through explicit porous microstructures

*Kent, Stuart*, Multi-scale conformal maps and free boundary problems

*Love, David*, Data-driven methods for optimization under uncertainty with application to water allocation

*Lyttle, David*, Modeling inhibition-mediated neural dynamics in the rodent spatial navigation system

*Mann, Sarah*, The original view of Reed-Solomon coding and the Welch-Berlekamp decoding algorithm

*Pennybacker, Matthew*, A numerical study of pattern-forming fronts in phyllotaxis

*Stockbridge, Rebecca*, Bias and variance reduction in assessing solution quality for stochastic programs

*Yang, Bole*, Asymptotic behaviors of CMV matrices and discrete nonlinear Schroedinger equations

STATISTICS GIDP

*Fang, Qijun*, Hierarchical Bayesian benchmark dose analysis

# ARKANSAS

## University of Arkansas at Fayetteville (4)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Foster, Newton*, General sampling schemes for the Bergman spaces

*Fulmer, Shanda*, Closed-range composition operators on weighted Bergman spaces and applications

*Tinker, Michael*, The Szegö kernel of certain polynomial models and heat kernel estimates for Schrödinger operators with reverse holder potentials

*Whittle, Carrie*, The word problem for the automorphism groups of right-angled Artin groups is in *P*

# CALIFORNIA

## California Institute of Technology (6)

APPLIED AND COMPUTATIONAL MATHEMATICS DEPARTMENT

*Amlani, Faisal*, A new high-order Fourier continuation-based elasticity solver for complex three-dimensional geometries

*Ci, Maolin*, Multiscale model reduction methods for deterministic and stochastic partial differential equations

*Sanan, Patrick*, Geometric elasticity for graphics, simulation, and computation

*Tavallali, Peyman*, Sparse Time-Frequency Data Analysis: A multi-scale approach

*Tyranowski, Tomasz*, Geometric integration applied to moving mesh methods and degenerate lagrangians

DEPARTMENT OF MATHEMATICS

*Daigle, Gerald*, On the local Tamagawa number conjecture for Tate motives

## Claremont Graduate University (13)

INSTITUTE OF MATHEMATICAL SCIENCES

*Abouali, Mohammad*, Investigating Castillo-Grone's mimetic difference operators in development of geophysical fluid dynamic models implemented on GPGPUS

*Akhter, Sajia*, Finding a novel way for fast sequence alignment and exploiting information theory in bacterial genomes and complete phages

*Chaumont, Nicolas*, Modeling animal interactions with their environment

*Chen, Jerry*, Role of the micro: RN A miR-124 in the regulatory network governing PNS development in Ciona intestinalis

*Franklin, Michael*, Electrowetting-based microfluidics: Modeling and simulation

*Garcia-Cardona, Cristina*, Multiclass learning on graphs: Diffuse interface models and beyond

*Nachawati, Susan*, DNA visualization with Sacks Spiral methods: An application in genomic engineering

*Recova, Leandro*, Applications of Morse theory to semilinear elliptic boundary value problems

*Seguritan, Victor*, Neural network predictions of protein function

*Sharpsten, Lucie*, Predicting glaucoma progression using random forests for correlated binary response based on longitudinally collected standard automated perimeter data

*Teagle-Hernandez, Allen*, Very efficient numerical solutions via the "Mehrstellan" methods in 1D, 2D, and 3D for complex differential equations demonstrated for acoustic and related fields

*Thomas, Mary*, Parallel implementation of the curvilinear ocean and atmospheric (UCOAM) model and supporting computational environment

*Zajac, Peter*, Globally accessible finite element based web solver for the vibrational Schrödinger equation and application to $HC_3O$ and $ZnCl_2$+

## Naval Postgraduate School (1)

DEPARTMENT OF APPLIED MATHEMATICS

*Chung, Jong*, Affine equivalence and constructions of cryptographically strong Boolean functions

## Stanford University (19)

DEPARTMENT OF MATHEMATICS

*Adams, Henry*, Evasion paths in mobile sensor networks

*Buchholtz, Ulrik*, Unfolding of systems of inductive definitions

*Carlotto, Alessandro*, Rigidity and flexibility phenomena in general relativity

*Grigoriev, Ilya*, Relations among characteristic classes of manifold bundles

*Ha, Junsoo*, Some problems in multiplicative number theory

*Haber, Nicholas*, Microlocal analysis of Lagrangian submanifolds of radial points

*Levin, Brandon*, *G* valued flat deformations and local models

*Li, Xiaodong*, Sparse and low rank structures in robust principal component analysis, compressed sensing with corruptions, and phase retrieval

*Lipnowski, Michael*, Equivariant torsion and base change

*Malkiewich, Cary*, Duality and linear approximations in Hochschild homology, *K* theory, and string topology

*Murphy, Daniel*, Algebraic modular forms on definite orthogonal groups

*Petrow, Ian*, Moments of automorphic *L* functions and related problems

DEPARTMENT OF STATISTICS

*Basak, Anirban*, Probability models on large random graphs and matrices

*Gavish, Matan*, Topics in matrix inference

*Grazier G'Sell, Maxwell*, Inference for correlation-based hierarchical clustering of variables

*Head, Austen*, Statistical methods on graphs

*Lim, Michael*, The group-lasso: Two novel applications

*Mukherjee, Sumit*, Estimation in exponential families with unknown normalizing constant

*Sun, Nike*, Gibbs measures and phase transitions on locally tree-like graphs

## University of California, Berkeley (39)

DEPARTMENT OF MATHEMATICS

*Beraldo, Dario*, Loop group actions on categories and Whittaker invariants

*Boocher, Adam*, Super flatness

*Bray, Nicolaus*, Methods for measurement and interpretation of gene expression

*Charalambidis, Marko*, External problems in analysis

*Chirvasitu, Alexandru*, Linearly reductive quantum groups: Descent, simplicity and finiteness properties

*Choi, Keon*, The embedded contact homology of toric contact manifolds

*Daub, Michael*, Complex and $p$-adic computations of Chow-Heegner points

*Do, Hanh*, Monoidal structure in mirror symmetry and noncommutative geometry

*Flock, Taryn*, On extremizers for certain inequalities of the $k$-plane transform

*Forman, Noah*, Instruction sets for walks and the quantile path transformation

*Froehle, Bradley*, High-order discontinuous Galerkin fluid-structure interaction methods

*Haken, Ian*, Randomizing reals and the first order consequences of 2-randoms

*Hurtado-Salazar, Sebastian*, Homomorphisms between groups of diffeomorphisms

*Kaspar, David*, Exactly solvable stochastic models in elastic structures and scalar conservation laws

*Mannisto, Peter*, Albanese and Picard 1-motives in positive characteristic

*McDougal, Shawn*, Representing Sato-Levine invariants by Whitney tower intersections

*Miles, Andrew*, Moduli of elliptic curves via twisted stable maps

*Nguyen, Khoa*, Arithmetic dynamics of diagonally split polynomial maps

*Ren, Qingchen*, Computations and moduli spaces for non-Archimedean varieties

*Rodriguez, Jose*, Numerical algebraic geometry for maximum likelihood estimation

*Solis, Pablo*, Wonderful loop group embeddings and applications to the moduli of $G$-bundles on curves

*Tener, James*, Construction of the unitary free fermion Segal conformal field theory

*Trang, Nam*, Generalized Solovay measures, the HOD analysis and the core model induction

*Tucker Simmons, Matthew*, Quantum algebras associated to irreducible generalized flag manifolds

*Vianna, Renato*, On exotic Lagrangian tori in $\mathbb{C}p^2$

*Watson, Nathaniel*, Non-simplicial nerves of two-dimensional categorical structures

*Westrick, Linda*, Computability in ordinal ranks and symbolic dynamics

*Yu, Thanh*, Combinatorial patterns in syzygies

DEPARTMENT OF STATISTICS

*Bean, Derek*, Non-gaussian component analysis

*Bhattacharyya, Sharmodeep*, A study of high-dimensional clustering and statistical inference on networks

*Huoh, Yu-Jay*, Sensitivity analysis of stochastic simulator with information theory

*Loh, Po-Ling*, High-dimensional statistics with systematically corrupted data

*Long, James*, Prediction methods for astronomical data observed with measurement error

*Sapp, Stephanie*, Subsemble: A flexible ensemble prediction method

*Tran, Ngoc*, Topics in tropical linear algebra and applied probability

GROUP IN BIOSTATISTICS

*Brown, Daniel*, Applications of causal inference in problems of occupational health

*Decker, Anna*, Semiparametric prediction, variable importance, and effect estimation in trauma care

*Eliseeva, Ekaterina*, Machine learning and causal inference methods for the derivation of exposure-response curves

*Pozzi, Luca*, Topics in evidence synthesis

## University of California, Davis (16)

DEPARTMENT OF MATHEMATICS

*Brummitt, Charles*, Models of systemic events: Interdependence, contagion and innovation

*Chong, Eun A.*, Nonlinear equations of mixed type and transonic flows

*Kwok, Ricky*, On the distribution of the leading particle in the ASEP with step initial condition and the self-adjoint ASEP

*Li, Lingyun*, Central limit theorem for linear statistic of eigenvalues of large random matrices

*O'Brien, Matthew*, Scalable domain decomposed Monte Carlo particle transport

*Reed, Matthew*, The central limit theorem for linear spectral statistics of submatrices of the Gaussian Wigner random matrices

DEPARTMENT OF STATISTICS

*Chou, Elizabeth*, Computed data-geometry based supervised and semi-supervised learning in high dimensional data

*Dienes, Christopher*, On-line monitoring in linear time series models

*Dienes, Erin*, An information theoretic approach to biomarker validation

*Huang, Chun-Jung*, Spatial-temporal models for image data analyses

*Jin, Yin*, Estimating component reliability using system lifetime data

*Noguchi, Kimihiro*, Exploratory analysis and modeling of financial time series

*Tao, Wenwen*, Represent derivatives and time dynamics for longitudinal data

*Wang, Ru*, High-dimensional graphical models learning

*Xu, Cong*, Semiparametric analysis of incomplete survival data

*Zhou, Siyuan*, Semiparametric modeling of non-autonomous dynamical systems

## University of California, Irvine (10)

DEPARTMENT OF MATHEMATICS

*Abatzoglou, Alexander*, A CM elliptic curve framework for deterministic primality proving on numbers of special form

*Feng, Jie*, Matrix factorization and its application in blind source separation and finance

*He, Fei*, Regularity of the Ricci flow and rigidity of Ricci solitons

*Holben, Ryan*, Lowering the consistency strength of square principles at singular cardinals

*Long, Xiaolong*, Constructing sparse and fast mean reverting portfolios

*Ryerson, Shane*, Ultrasensitivity and parameter variability in independent multisite systems

*Said, Mustafa*, Almost commuting elements in non-commutative symmetric operator spaces

*Sun, Zheng*, Modeling of stem cells

*Wang, Dongyong*, Numerical methods for reaction diffusion systems in high spatial dimensions

*Wang, Lihan*, Hodge theory on compact symplectic manifolds with boundaries

## University of California, Los Angeles (22)

DEPARTMENT OF MATHEMATICS

*Alexander, Damon*, Limiting evolution of families of parabolic differential equations

*Barekat, Farzin*, Applications of stochastic simulation and compressed sensing to large systems

*Chen, Xiaojing*, Global Torelli theorem for projective manifolds

*Das, Shagnik*, Extensions of classic theorems in extremal combinatorics

*David, Guy*, Lipschitz maps in metric spaces

*Hayes, Benjamin*, Extended von Neumann dimension for representations of groups and equivalence relations

*Howes, Russell*, Virtual node methods for incompressible flow

*Kinneberg, Kyle*, A coarse entropy-rigidity theorem and discrete length-volume inequalities

*Kostic, Tijana*, Threshold dynamics for statistical density estimation and graph clustering

*Li, Yingkun*, Mock-modular forms of weight one

*Murphy, Jason*, Nonlinear Schrödinger equations at non-conserved critical regularity

*Richelson, Silas*, Cryptographic protocols with strong security: Non-malleable commitments, concurrent zero-knowledge and topology-hiding multi-party computation

*Ricketson, Lee*, Two approaches to accelerated Monte Carlo simulation of Coulomb collisions

*Rodgers, Bradley*, The statistics of the zeros of the Riemann zeta-function and related topics

*Sanders, Beren*, Higher comparison maps for the spectrum of a tensor triangulated category

*Schaeffer, Hayden*, Variational models for fine structures

*Skoufranis, Paul*, Approximations in operator theory and free probability

*Ventullo, Kevin*, On the Gross-Stark and Iwasawa main conjectures

*Yang, Yi*, Fast and robust algorithms for compressive sensing and other applications

*Zahl, Joshua*, Maximal functions, incidence theorems, and efficient partitions of Euclidean space

*Zhao, Bin*, Local indecomposability of Hilbert modular representations and Mumford-Tate conjecture

DEPARTMENT OF STATISTICS

*Levinson, Matthew*, Penalized Bayesian model selection and prediction for gene regulation in higher organisms

## University of California, Merced (4)

DEPARTMENT OF APPLIED MATHEMATICS

*Loffeld, John*, Design, implementation and performance of exponential integrators for high performance computing applications

*Rohde, Shelley*, Modeling diffuse reflectance measurements of light scattered by layered tissues

*Sahin, Derya*, Modeling light propagation in luminescent media

*Vaz, Garnet*, Graph based scalable algorithms with applications

## University of California, Riverside (4)

DEPARTMENT OF MATHEMATICS

*Kim, Chunghoon*, Deformations of compact holomorphic Poisson manifolds and algebraic Poisson schemes

DEPARTMENT OF STATISTICS

*Guo, Li*, Near uniformly minimum variance quadratic unbiased estimation of variance components in mixed effects models

*Yue, Liu*, Estimation of two popular econometric models: Random effects panel data model and simultaneous equations model

*Xin, Zhang*, Sequential procedures for nonparametric statistical process control and longitudinal data classification

## University of California, San Diego (10)

DEPARTMENT OF MATHEMATICS

*Briggs, Christopher*, Uniform exponential growth in algebras

*Gao, Teng*, A rearrangement inequlity for diffusion process

*Meredith, Michael Brandon*, Mirror symmetry on toric varieties via tropical geometry

*Mihalik, Adam*, Adaptive methods in the finite exterior calculus framework

*Rodriguez, Ryan*, Preperfectoid algebras

*Timmons, Craig*, Extremal graphs and additive combinatorics

*Walsh, Katherine P.*, Patterns and stability in the coefficients of the color Jones polynomial

*Wang, Li*, Semidefinite relaxation approach to polynomial optimization and its extension

*Wildman, Chad*, Global existence and dispersion of solutions to nonlinear Klein-Gordon equations with potential

*Zhang, Zezhou*, Nonassociative algebra and groups with property

## University of California, Santa Barbara (7)

DEPARTMENT OF MATHEMATICS

*Flores, Cynthia*, On decay properties of solutions to the Benjamin-Ono equation

*Harrison, Martin*, Quadratic convexity and sums of squares

*Jaramillo, Andrew*, Unipotent radicals of the standard Borel and parabolic subgroups in quantum special linear groups

*Jaramillo, Maree*, The structure of fundamental groups of smooth metric measure spaces

*Plunkett, Patrick*, Spatially adaptive numerical methods for stochastic biophysical processes

*Sigurdsson, Jon Karl*, Continuum and coarse-grained modeling of lipid bilayer membranes

*Speer, Timothy*, Isometries of the Hilbert metric

## University of California, Santa Cruz (9)

APPLIED MATHEMATICS AND STATISTICS DEPARTMENT

*Anderson, Ross*, Uncertainty-anticipating stochastic optimal feedback control of autonomous vehicle models

*Beltran, Francisco*, Quantifying the impact of climate change on oceanic variables

*Guenther, John*, Optimization with global sensitivity analysis and optimum characterization

*Poynor, Valerie*, Bayesian nonparametric gamma mixtures for mean residual life inference

DEPARTMENT OF MATHEMATICS

*Brasher, Reuben*, Asymptotics of determinants of a class of perturbed Toeplitz matrices

*Dods, Victor*, What happens when you push a cubic meter of Jello into a wormhole

*Laber, Robert*, $C$-graded vertex algebras and their representations

*Magee, Michael*, Quantitative spectral gap for thin groups of hyperbolic isometries

*Perepelitsky, Philipp*, $P$-permutation equivalences between blocks of finite groups

## University of Southern California (11)

DEPARTMENT OF MATHEMATICS

*Avdek, Russell*, Liouville hypersurfaces and connect sum cobordisms

*Bañuelos, Selenne*, Structured two-stage population model with migration between multiple patches in a periodic environment

*Bilal, Taylan*, Some computations for bivariant cycle cohomology

*Chubatiuk, Alona*, Nonparametric estimation of an unknown probability distribution using maximum likelihood and Bayesian approaches

*Ericksen, Adam*, The geometry of motivic spheres

*Marinov, Radoslav*, Applications of Stein's methods on statistics of random graphs

*Ostrovskyi, Vitalli*, Point singularities on 2D surfaces

*Pike, John*, Eigenfunctions for random walks on hyperplane arrangements

*Wasilewska, Katarzyna*, Limiting distributions and error terms for the number of visits to balls in mixing dynamical systems

*Xu, Li*, Parameter estimate for hyperbolic SPDE's with stochastic coefficients

*Yildirim, Gokhan*, On the depinning transition of the directed polymer in a random environment with a defect line

# COLORADO

## Colorado School of Mines (1)

Department of Applied Mathematics and Statistics

*Probst, Alexandre*, A tablet-PC software application for statistics classes

## Colorado State University (12)

Department of Mathematics

*Maple, Jennifer*, Steady state Hopf mode interaction in anisotropic system

*Munoz-Alicea, Roberto*, HIV-1 gag trafficking and assembly; mathematical models and numerical simulations

*Ross, Dustin*, Open and closed Gromov-Witten theory of three dimensional toric Calabi-Yau orbifolds

*Salvi, Niketa*, Two-step coding theorem in the nearly continuous category

*Springer, Bethany*, Nearly continuous Kakutani equivalence

*Strickland, Christopher*, The mathematical modeling and analysis of nonlocal invasions and savanna population dynamics

*Ziegelmeier, Lori*, Exploiting geometry, topology and optimization for knowledge discovery in big data

Department of Statistics

*Hanks, Ephraim*, Statistical models for animal movement and landscape connectivity

*He, Zonglin*, Nonparametric regression with categorical covariates

*Schliep, Erin*, Spatial probit models for multivariate ordinal data: Computational efficiency and parameter identifiability

*Wang, Huan*, Shape restricted spline regression and hypothesis tests in the presence of correlation

*Wang, Yuan*, Linear system design for compression and fusion

## University of Colorado, Boulder (11)

Department of Applied Mathematics

*Galanthay, Theodore*, On adaptive use of information in habitat selection

*Garcia, Jose*, Beta-plane approximation of wind-driven ocean circulation using a first order system least-squares formulation

*Jones, Tobias*, Algebraic multigrid methods for parallel computing, systems, and graphs

*Rasca, Anthony*, Modeling solar wind mass-loading due to dust in the solar corona

*Sen, Amrik*, A tale of waves and eddies in a sea of rotating turbulence

*Webb, Adrean*, Stokes drift and meshless wave modeling

Department of Mathematics

*Andrews, Scott*, Type-free approaches to supercharacter theories of unipotent groups

*Feaver, Amy*, Euclid's algorithm in multi-quadratic fields

*Keller, Justin*, Generalized supercharacter theories and Schur rings for Hopf algebras

*Purkis, Benjamin*, Projective multiresolution analyses over irrational rotation algebras

*Wayne, David*, The $K$-theory of filtered deformations of graded polynomial algebras

## University of Colorado, Denver (8)

Department of Biostatistics and Informatics

*Brinton, John*, Statistical methods for cancer screening

*Kreidler, Sarah*, Calculating power for the general linear multivariate model and the general linear mixed model

*Kroehl, Miranda*, On the use of lasso regression for mediation analysis with application to microbiota data

*Ringham, Brandy*, Reducing decision errors in repeated measures studies with missing data

Department of Mathematics and Statistical Sciences

*Erbes, Catherine*, Extremal problems for degree sequences

*Lowery, Bradley*, Topics in communication-avoiding algorithms and stability analysis

*Morris, Timothy*, New results on cycle structures of graphs

*Nabity, Matthew*, On accelerating the nonsymmetric eigenvalue problem in multicore architectures

## University of Denver (1)

Department of Mathematics

*Trujillo, Timothy*, Topological Ramsey spaces, associated ultrafilters, and their applications to the Tukey theory of ultrafilters and Dedekind cuts of non-standard arithmetic

## University of Northern Colorado (3)

School of Mathematical Sciences

*Dibbs, Rebecca*, The effects of formative assessment on students' Zone of Proximal Development in introductory calculus

*Glassmeyer, David*, Secondary teacher models of quantitative reasoning

*Roberson, Lee*, Building bridges: Connecting collegiate athletic and mathematics cultures

# CONNECTICUT

## University of Connecticut, Storrs (16)

Department of Mathematics

*Baldenko, Alex*, The top Lyapunov exponent of symplectic stochastic differential equations: Theory and numerics

*Canakci, Ilke*, Snake graph calculus and cluster algebras from surfaces

*Gunathilaka, Unawatuna Gamage Asiri*, Property and casualty claim cost management

*Kelleher, Daniel*, Geometric techniques in analysis on fractals

*Lamoureux, Matthew*, Stirling's formula in number fields

*Li, Ji*, Topological and isotopic equivalence with applications to visualization

*Lu, Lu*, On the integrated squared error of the linear wavelet density estimator

Department of Statistics

*Boyko, Jennifer*, Handling data with three types of missing values

*Chaurasia, Ashok*, Model selection procedures for incomplete data

*Jiang, Xun (Tony)*, A new classs of link functions for modeling categorical data with applications in biology

*Liao, Gong-Yi*, Residual likelihood based clustering models

*Pare, Valerie*, Impact of prior distribution uncertainty in multiple imputation inference

*Rayaprolu, Sairam*, Multiple testing under dependence with approximate posterior likelihood

*Shang, Hongwei*, A two-step estimation procedure and a goodness-of-fit test for spatial extremes models

*Viran Muthu Poruthotage, Sankha*, Multiple crossing fixed-size sequential confidence regions for the mean vector and regression parameters under multivariate normality

*Wang, Xiao (Leo)*, Scan statistics for normal data

## Wesleyan University (4)

Department of Mathematics and Computer Science

*Bourdon, Abbey*, A uniform version of a finiteness conjecture for elliptic curves with complex multiplication

*Graham, Bonita*, A construction of rigid analytic cohomology classes for split reductive algebraic groups

*Ricci, James*, Finiteness results for regular ternary quadratic polynomials

*White, David*, Monoidal Bousfield localizations and algebras over operads

## Yale University (7)

BIOSTATISTICS DIVISION

*Ryslik, Gregory*, Identification of non-random somatic mutation clustering while accounting for protein tertiary structure: Extensions, novel methodologies and applications to identifying oncogenic driver mutations

DEPARTMENT OF MATHEMATICS

*Banerjee, Soumya*, Tropical geometry over higher dimensional local fields

*Frailey, Conor*, Representations of the general linear groupoid over a non-Archimedean local field

*Li, Han*, Some effective results in homogeneous dynamics and number theory

*Shen, Linhui*, Geometry of canonical bases and mirror symmetry

DEPARTMENT OF STATISTICS

*Cho, Sanghee*, High-dimensional regression with random design, including sparse superposition codes

*Wang, Xiaofei*, Generalized Bayesian change point analysis via product partition models

# DELAWARE

## Delaware State University (2)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Chen, Feiyu*, Simulation of partial volume averaging in a software breast phantom

*Zeng, Fang*, Direct methods for interior inverse scattering problem

## University of Delaware (7)

DEPARTMENT OF MATHEMATICAL SCIENCE

*Deng, Quan*, Tear film modeling in 1D and 2D moving geometry with high-order method

*Fu, Zhixing*, Contributions to the study of the hybridizable discontinuous Galerkin method

*Han, Qunhui*, Analysis and simulation of exit time problems

*Li, Jing*, Staggered-grid FDTD method for ultrasound propagation through cancellous bone

*Lu, Sijiang*, Delta BEM discretization of transient and harmonic waves

*Wu, Fan*, Strongly regular graphs, association schemes and Gauss sums

*Xiao, Zunlei*, Gaussian and related processes: Lower tail probability and application

# DISTRICT OF COLUMBIA

## George Washington University (12)

DEPARTMENT OF MATHEMATICS

*Herning, Joseph*, Spectrum and factors of substitution dynamical systems

*Maeda, Kai*, Self-distributed magmas and their Richter's degrees

*Xie, Lu*, Analysis of the long range interaction in the ternary system

DEPARTMENT OF STATISTICS

*Biswas, Bipasa*, Statistical analysis of DNA copy number variation with sequencing data

*Chowdhury, Mohammed*, Nonparametric smoothing estimation of conditional distribution functions with longitudinal data and time-varying parametric models

*Kalpathy, Ravi*, Perpetuities in fair leader election algorithms

*Qing, Siyu*, Longitudinal weight calibration with estimated control totals for cross sectional survey data: Theory and applications

*Temprosa, Marinella*, An imputation-estimation algorithm using time-varying auxiliary covariates for a longitudinal model when outcome is missing by design

*Xu, Ruihua*, Analysis of mixed types of traits in genetic association studies and application to genome-wide association studies

*Xu, Wenjing*, Statistical properties of biostatistical methods for correlated processes with application to data arising in the legal settings

*Yang, Mengta*, Depth functions, multidimensional medians, and tests of uniformity on proximity graphs

*Zhang, Fanni*, Concordant integrative analysis of multiple gene expression data sets

## Howard University (7)

DEPARTMENT OF MATHEMATICS

*Foster, Bertrum*, Rational points and isogenies of the Holm curves over finite fields

*Fulton, Kourtney*, Continuous homomorphism from $\beta S$ to $S^*$

*Kayende, Oliver*, Character sum bounds and hyperforms on binary group algebras

*Miabey, Teylama*, Spectral analysis for finite rank perturbations of diagonal operators in non-Archimedean Hilbert space

*Nelson, Valerie*, Existence results for some higher-order abstract differential equations with applications to PDEs

*Peters, Monique*, Characterizing differences between the left and right operations on $\beta S$

*Phulara, Dev*, A generalization of the Central Sets Theorem with applications and some additive and multiplicative Ramsey numbers

# FLORIDA

## Florida Atlantic University (1)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Zhang, Wei*, Detection of multiple change-points in hazard models

## Florida Institute of Technology (1)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Alharthi, Nadiyah*, A piecewise WKB approximation for One-Turning-Point Sturm-Liouville equations and asymptotics for eigenvalues

## Florida State University (28)

DEPARTMENT OF MATHEMATICS

*Amusan, Ibukun*, Parameter estimation for a stochastic volatility model with coupled additive and multiplicative noise

*Daou, Arij*, From songs to ion channels and mathematical modeling

*Garreau, Pierre*, Jump dependence and multidimensional default risk: A new class of structural models with stochastic intensities

*Geng, Jian*, Calibration of local volatility models and proper orthogonal decomposition reduced order modeling for stochastic volatility models

*He, Yanyan*, Uncertainty quantification and data fusion based on Dempster-Shafer theory

*Huang, Wanwan*, Stochastic modeling of financial derivatives

*Huang, Wen*, Optimization algorithms on Riemannian manifolds with applications

*Islim, Ahmed Derar*, Pricing and hedging derivatives with sharp profiles using tuned high resolution finite difference schemes

*Liao, Xia*, Chern classes of sheaves of logarithmic vector fields for free divisors

*Liu, Yaning*, Non-intrusive methods for probabilistic uncertainty quantification and global sensitivity analysis in nonlinear stochastic phenomena

*Lu, Yuanting*, Discrete Frenet frame with its application of structural biology and kinematics

*Ohm, Candace*, The evolution of deception in signaling systems

*Wang, Dongxu*, 3-manifolds of S1-category three

*Whidden, Mark*, Numerical methods for multiphase systems with applications to biology

*Winters, Andrew*, Discontinuous Galerkin spectral element approximations for the reflection and transmission of waves from moving material interfaces

*Zhang, Yuan*, Modeling high frequency order book dynamics with support vector machines

DEPARTMENT OF STATISTICS

*Almansour, Aseel*, The risk of lipids on coronary heart disease: Prognostic models and meta-analysis

*Bryner, Darshan*, 2D affine and projective shape analysis and Bayesian elastic active contours

*Chung, Steve*, A class of semiparametric volatility models with applications to financial time series

*Girimurugan, Senthil Balaji*, Nonlinear multivariate tests for high-dimensional data using wavelets with applications in genomics and engineering

*Ha, Seung-Yeon*, Theories on group variable selection in multivariate regression models

*Holden, Robert*, Failure time regression models for thinned point processes

*Laborde, Jose*, Elastic shape analysis of proteins and RNAs

*Nilles, Ester*, An ensemble approach to predicting health outcomes

*Su, Jingyong*, Statistical analysis of trajectories on Riemannian manifolds

*Tang, Yuanyuan*, Bayesian methods for skewed response including longitudinal and heteroscedastic data

*Tao, Yingfeng*, The frequentist performance of some Bayesian confidence intervals for the survival function

*Williams, Felicia*, The relationship of diabetes to coronary heart disease mortality: A meta-analysis based on person level data

## University of Central Florida (6)

DEPARTMENT OF MATHEMATICS

*Benhaddou, Rida*, Nonparametric and empirical Bayes estimation models

*Haussermann V, John William*, Tiling properties of spectra of measures

*Losert, Bernd*, Extensions of $S$-spaces

*Michalak, Martin*, Dynamical invariants and the fluid impulse in plasma models

*Pridemore, Kathryn*, Accelerated life model with various types of censored data

*Van Gorder, Robert*, Nonlinear dispersive partial equations of physical relevance with application to vortex dynamics

## University of Florida (26)

DEPARTMENT OF MATHEMATICS

*Broschinski, Adam*, Eigenvalues of self-adjoint Toeplitz operators with respect to a constrained algebra

*Feng, Wei*, Charge transport analysis for lightning

*Gluck, Matthew*, Blow-up analysis and classification theorems for solutions to semi-linear elliptic equations

*Guo, Ying*, Energy estimates and Harnack type inequalities for prescribing curvature type equations with boundary conditions

*Homberger, Cheyne*, Patterns in permutations and involutions: A structural and enumerative approach

*Hou, Hongyan*, Convergence analysis of orthogonal collocation methods for unconstrained optimal control

*Hungerford, James*, The vertex separator problem and edge-concave quadratic programming

*Huynh, Duc*, Problems on finite extensions of local function fields

*Inman, Jessica*, Examples of reaction-diffusion equations in biological systems: Marine protected areas and quorum sensing

*Lauderdale, Lindsey-Kay*, Maximal subgroups of finite groups

*Lee, JoAnn*, A simulation model for the spread of citrus greening via transmission between flush shoots and Diaphorina citri

*Li, Jie*, Multiset graph partitioning

*Mico-Umutesi, Delphine*, Estimating the violation of the KKT conditions

*Newton, Robert*, On Lusternik-Schnirelmann category of connected sums

*Ouyang, Yuyuan*, Optimal first order methods for a class of non-smooth convex optimization with applications to image analysis

*Richards, Trevor*, On level curves and conformal equivalence of meromorphic functions

*Shi, Jiangli*, Statistical dependence measure based multi-model image registration and registration assisted nonparametric image segmentation

*Stetler, Eric*, Multiplication operators on Hilbert spaces of Dirichlet series

*Stupiansky, Jillian*, Mathematical modeling of citrus greening

*Zhang, Haili*, Mathematical modeling for image segmentation and restoration

DEPARTMENT OF STATISTICS

*Dasgupta, Shibasish*, High dimensional inference and variable selection

*Gaskins, Jeremy*, Bayesian methods for modeling dependence structures in longitudinal data

*Huang, Lei*, Survival and reliability analysis under Polya tree processes priors

*Kim, Chan Min*, Bayesian methods for inference on the causal effects of mediation

*Li, Ke*, Bayesian multiple testing under sparsity for exponential distributions

*Wang, Shu*, Extending the Nadaraya-Watson estimator for data with spatially correlated errors

## University of Miami (2)

DEPARTMENT OF MATHEMATICS

*Gonzalez DeLeon, Rafael*, On the combinatorics of the free Lie algebra with multiple brackets

*Liu, Yijia*, Hodge theoretic aspects of categorical spectrum

## University of South Florida (6)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Bonsu, Nana Osei*, Age dependent analysis and modeling of prostate cancer data

*Chan, Yiu Ming*, Statistical analysis and modeling of prostate cancer

*De Castro, Lisa*, Analytic functions with real boundary values in Smirnov classes $E^p$

*Pokhrel, Keshav*, Statistical analysis and modeling of brain tumor data: Histology and regional effects

*Teodorescu, Iuliana*, Optimization in nonparametric survival analysis and climate change modeling

*Zerihun, Tadesse*, Nonlinear techniques for stochastic systems of differential equations

# GEORGIA

## Emory University (6)

DEPARTMENT OF BIOSTATISTICS AND BIOINFORMATICS

*Ling, Qiang*, Bayesian spatial-temporal models for areal count data

*Mitchell, Emily*, Regression models for a continuous outcome subject to pooling

MATHEMATICS AND COMPUTER SCIENCE DEPARTMENT

*Chu, Qing*, Numerical methods for wavefront reconstruction

*Jameson, Marie*, Combinatorial objects at the interface of $q$-series and modular forms

*Klymko, Christine*, Centrality and communicability measures in complex networks: Analysis and algorithms

*Rolen, Larry*, Maass forms and quantum modular forms

## Georgia Institute of Technology (9)

SCHOOL OF MATHEMATICS

*Amirkhanyan, Gagik*, Problems in combinatorial number theory

*Backman, Spencer*, Combinatorial divisor theory for graphs

*Casey, Meredith*, Branched covers of contact manifolds

*Liu, Jingfang*, Adaptive iterative filtering methods for non-linear signal analysis and applications

*Lu, Jun*, Method of evolving junctions: A new approach to path planning and optimal control

*Shin, Hyunshik*, Algebraic degrees of stretch factors in mapping class groups

*Shokrieh, Farbod*, Divisors on graphs, binomial and monomial ideals, and cellular resolutions

*Winarski, Rebecca*, Symmetry, isotopy, and irregular covers

*Yin, Ke*, New algorithms for solving inverse source problems with applications in flourescence tomography

## Georgia State University (4)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Burns Childers, Annie*, Calculus students' understanding of the derivative in relation to the vertex of a quadratic function

*Malec, Sara*, Intersection algebras and pointed rational cones

*Meadows, Leslie*, Iteratively regularized methods for inverse problems

*Wang, Yanhong*, Clustering, classification, and factor analysis in high dimensional data analysis

## University of Georgia (17)

DEPARTMENT OF MATHEMATICS

*Berglund, Michael*, Bounding expected values on random polygons

*Doyle, John*, Dynamics of quadratic polynomials over quadratic fields

*Musgrave, Stacy*, Structure and representation of alternative Clifford algebras of quadratic forms

*Nguyen, Duc Duy*, Optimal asset trading under regime switching models

*Shin, Jae Ho*, The reduction map for the moduli spaces of weighted stable hyperplane arrangements

*Talian, Andrew*, Endotrivial modules for classical Lie superalgebras

*Tenini, Joseph*, Results on an extended Torelli map and singularities of degenerate Abelian varieties

*Thompson, Katherine*, Explicit representation results of quadratic forms over QQ and QQ($\sqrt{5}$) by analytic methods

DEPARTMENT OF STATISTICS

*Brown, Andrew*, Bayesian multiple testing under dependence with application to functional magnetic resonance imaging

*Hilafu, Haileab*, On dimension reduction and feature selection in high dimensions

*Lee, Jinae*, Functional magnetic resonance imaging data clustering

*Lee, Jung Ae*, Sample integrity in high dimension

*Liu, Xinyu*, Sample size determination in multi-class classification and prediction based on single-nucleotide polymorphisms

*Samadi, Yaser*, Matrix time series analysis

*Sun, Lin*, Bayesian factor analysis for fMRI data

*Wu, Hsin-Ping*, Locally optimal designs for generalized linear models

*Zhang, Nan*, Hilbert-Schmidt independence criterion in sufficient dimension reduction and feature screening

# HAWAII

## University of Hawaii at Manoa (2)

DEPARTMENT OF MATHEMATICS

*Marriott, John*, Geometric optimal control with an application to imaging in nuclear magnetic resonance

*Yoshida, Rintaro*, Linear and non-linear operators, and the distribution of zeros of entire functions

# IDAHO

## Idaho State University (1)

DEPARTMENT OF MATHEMATICS

*Baird, Daniel*, Introduction to math education analysis: A textbook for mathematics graduate teaching assistants

## University of Idaho (2)

DEPARTMENT OF MATHEMATICS

*Liu, Zhenia*, Conditional persistence for random walks

*Torrance, Douglas*, Nondefective secant varieties of varieties of completely decomposable forms

# ILLINOIS

## Illinois Institute of Technology (1)

APPLIED MATHEMATICS DEPARTMENT

*Balint, Gergely*, Non-adaptive group testing Steiner systems and Latin squares

## Illinois State University (5)

DEPARTMENT OF MATHEMATICS

*Cross, Laban*, Student's development and use of internal representations when solving algebraic tasks

*Hertel, Joshua*, Investigating the purpose of trigonometry in the modern sciences

*Kara, Melike*, Students' reasoning about invariance of volume as a quantity

*Scranton, Melissa*, Examining middle school students' statistical thinking while working in a technological environment

*Wickstrom, Megan*, An examination of teachers' perceptions and implementation of learning trajectory based professional development

## Northern Illinois University (8)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Bailey, Christopher*, The MP algorithm and its applications

*Ghosh, Santu*, Smoothed bootstrap percentile ellipsoidal confidence region for mean vector

*McCombs, Paul*, Analysis of second semester calculus students' understanding of series and series convergence

*McCullough, Kristin*, An application of statistics in nanotechnology

*Montz, Allen*, Some bipolar viscous fluid flow problems in rigid and compliant domains

*Patel, Rita*, A mixed methods analysis of calculus students' understanding of slope and derivative concept

*Saint-George, Thomas*, Nodal solutions of nonlinear boundary value problems with multi-point boundary conditions

*Wangle, Jayleen*, Calculus student understanding of continuity

## Northwestern University (18)

DEPARTMENT OF MATHEMATICS

*Bobkova, Irina*, Resolutions in the $K(2)$-local category at the prime 2

*Hoyois, Marc*, A quadratic refinement of the Grothendieck-Lefschetz-Verdier trace formula

*Matsuoka, Takuo*, Descent and the Koszul duality for locally constant factorisation algebras

*Potash, Eric*, Euclidean embeddings and Riemannian Bergman metrics

*Zhang, Zhenghe*, Positivity and continuity of Lyapunov exponents for one-frequency, smooth quasi-periodic Schrödinger operators

DEPARTMENT OF STATISTICS

*Gou, Jiangtao*, Topics in $p$-values based multiple test procedures

*Li, Cheng*, On likelihood-free Bayesian inference, model selection and risk minimization for increasing dimensional data

*McCallum, Kenneth*, Modeling read distributions in high-throughput sequencing datasets

*Xi, Dong*, Topics in gatekeeping and group sequential procedures for multiple endpoints

*Zhao, Yu*, On asymptotic distributions and confidence intervals for LIFT measures in data mining

*Zhao, Zhenyu*, Integrated likelihood computation method and application

ENGINEERING SCIENCES AND APPLIED MATHEMATICS DEPARTMENT

*Hansen, Samantha*, Newton methods for large scale problems in machine learning

*Johnson, Travis*, Inexact active-set algorithms for nonlinear and quadratic optimization

*McConnell, Lane*, A numerical investigation of the electrohydrodynamics of lipid bilayer vesicles

*Piet, David*, Mathematical models, analytical solutions and numerical simulations of self-assembled magnetic colloidal structures

*Vogl, Christopher*, Moving boundary problems with anomalous diffusion and a level set, immersed interface method

*Woolley, Olivia*, The individual's perspective of the network: Universality in transportation, the resilience of global mobility, and the dynamics of voluntary vaccination with information

*Yaple, Haley*, Mathematical models for the dynamics of competitive systems, with applications to religious shift and ferromagnetism

## Southern Illinois University-Carbondale (6)

DEPARTMENT OF MATHEMATICS

*Adatorwovor, Dayana*, $H$-removable sequences of graphs

*Al-Talib, Mohammad*, Statistical models utilizing dependence between variables

*Boone, Joshua*, Higher-order Lucas sequences and Dickson polynomials

*Tosun, Cemile*, Explicit factorization of generalized cyclotomic polynomials of order $2^m3$ over a finite field $F_q$

*Tosun, Kursad*, Qualitative and quantitative analysis of stochastic models in mathematical epidemiology

*Yi, Huijun*, Constrained statistical inference when target and sample populations differ

## University of Chicago (17)

DEPARTMENT OF MATHEMATICS

*Alvisio, Marcelo*, Applications of stochastic calculus to Schramm-Loewner evolution and option pricing

*Borman, Matthew Strom*, Symplectic quasi-states and Lagrangian topology

*Dobrovolska, Galyna*, Finite local systems in the Drinfeld-Laumon construction

*Gekhtman, Ilya*, Dynamics of convex cocompact subgroups of mapping class groups

*Hoyer, Rolf*, Two topics in stable homotopy theory

*Jenkins, Evan*, A double construction for pointed Lie 2-algebras

*Mann, Kathryn*, Components of representation spaces

*Merling, Mona*, Equivariant algebraic $K$-theory

*Naik, Vipul*, Lazard correspondence up to isoclinism

*Nguyen, Thi Thao*, The Dirichlet and regularity problems for second order linear elliptic operators in bounded Lipschitz domains

*Shao, Yuan*, Maximal displacement of critical branching random walks and symmetric stable processes

*Stephenson, Jonathan*, Topics in computability: Boolean algebras and effective packing dimension

*Studenmund, Daniel*, Abstract commensurators of lattices in solvable Lie groups and solvable $S$-arithmetic groups

*Wilson, Jennifer*, $FI_{\mathscr{W}}$-modules and stability phenomena for representations of classical Weyl groups

*Wright, Alexander*, Affine invariant submanifolds of the moduli space of abelian differentials

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*Petkova, Desislava*, Inferring effective migration from geographically indexed genetic data

*Reimherr, Matthew*, Functional data methods for genome wide association studies

## University of Illinois at Chicago (23)

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*Kaufman, Derrick*, Multivariate survival analysis of macrovascular events in veterans with type 2 diabetes

*Zhao, Weihan*, Statistical methodologies for group comparisons of brain connectivity using multimodal neuroimaging data

MATHEMATICS, STATISTICS AND COMPUTER SCIENCE DEPARTMENT

*Bourque, Matthew Joseph*, A policy improvement algorithm for some classes of stochastic games

*Brasile, Andrew Leland*, Essential spun-normal surfaces via tropical geometry

*Cooper, Jeffrey*, Independent sets in sparse hypergraphs

*Diochnos, Dimitrios Ioannis*, Analysis of algorithms in learning theory and network analysis of knowledge bases

*Groff, Bradley Williams*, Splittings of relatively hyperbolic groups

*Gross, Elizabeth Ann*, Algebraic complexity in statistics using combinatorial and tensor methods

*Haidau, Cristina*, A study of well posedness for systems of coupled non-linear dispersive wave equations

*Huang, Hsin-Hsiung*, Information extraction for virus classification and robust dimension reduction

*Krieger, Holly Christine*, Primitive prime divisors in polynomial dynamics

*Liang, Hao*, Equation problem over central extensions of hyperbolic groups

*Lombardi, Luigi*, Derived equivalences of irregular varieties and constraints on Hodge numbers

*Lozano Huerta, Cesar*, Birational geometry of complete quadrics

*Luo, Xue*, A novel algorithm to solve the nonlinear filtering problems in real-time

*Reschke, Paul Michael*, Cohomological insights for complex surface automorphisms with positive entropy

*Sahota, Davender Singh*, Borel complexity of the isomorphism relation for o-minimal theories

*Simmons, William D.*, Completeness of finite-rank differential varieties

*Wechter, Matthew A.*, Differential operators on finite purely inseparable extensions

*Xu, Tu*, New developments of minimum clinically important difference: Theory and methodology

*Ye, Hexi*, Complex dynamics: Schwarzian derivatives and measures of maximal entropy

*Zeng, Jiewei*, Optimal designs for multi-exponential models with covariance structure

*Zhang, Zhifan*, Portfolio choice with general pricing kernel

## University of Illinois, Urbana-Champaign (19)

DEPARTMENT OF MATHEMATICS

*Bankovic, Anja*, Length functions in flat metrics

*Carty, Thomas*, Analysis of a 1D approximation of the Boltzmann equation: The subclass of grossly determined solutions and the asymptotic behavior of the class of general solutions

*Choi, Ilkyoo*, Extremal problems on variations of graph colorings

*DeJarnette, Noel*, Self-improving Orlicz-Poincaré inequalities

*Faruk, Temur*, Linear and bilinear restriction estimates for the Fourier transform

*Fu, Ser-Wei*, Ridigity of length functions over strata of flat metrics

*Im, Mee Seong*, On semi-invariants of filtered representations of quivers and the cotangent bundle of the enhanced Grothendieck-Springer resolution

*Jahanbekam, Sogol*, Extremal problems for labelling of graphs and distance in digraphs

*Jeon, Bo Gwang*, Hyperbolic 3-manifolds of bounded volume and trace field degree

*Kim, Jaehoon*, Extremal problems involving forbidden subgraphs

*Konstantoulas, Ioannis*, Effective multiple mixing in Weyl chamber actions

*Lansing, Jennifer*, On the Stern sequence and a related sequence

*Li, Chunyi*, Deformations of the Hilbert scheme of points on a del Pezzo surface

*Ray, Brian*, Rigidity in free groups

*Son, Sarah Soojin*, Spectral problems on triangles and disks: Extremizers and ground state resolution

*Xiao, Jiajie*, Distribution of some arithmetic sequences

*Xiao, Lechao*, Sharp estimates for trilinear oscillatory integral forms

*Xu, Ping*, Identities involving theta functions and analogues of theta functions

*Yancey, Kelly*, Uniformly rigid homeomorphisms

# INDIANA

## Indiana University, Bloomington (16)

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*Attenborough, Holly*, On noninvertible cohomology arising from idempotents in the Brauer monoid

*Chao, Khek Lun Harold*, Rigidity of group actions on CAT(0) spaces

*Chung, Yu-Min*, On the computation of inertial manifolds, foliations, and tracking initial conditions

*Coti Zelati, Michele*, Differential inclusions and variational inequalities related to the primitive equations of the atmosphere

*Fadali, Tarek*, Spin and homotopy topological field theory in dimension 2

*Huang, Aimin*, Initial and boundary value problems for the primitive equations and shallow water equations

*Hui, Chun Yin*, Monodromy of Galois representations and equal-rank subalgebra equivalence

*Jung, Soyeun*, Pointwise nonlinear stability and asymptotic behavior of periodic traveling-wave solutions of systems of reaction-diffusion equations and of conservation laws

*Neese, Brandon*, Numerical simulations regarding turbulence and convection

*Pinzon Caicedo, Juanita*, Independence of satellites of torus knots in the smooth concordance group

*Poelhuis, Jonathan*, Medians and weighted local estimates for singular integral operators

*Ratnayake, Jayampathy*, On the forms of weak crossed product algebras

*Riggs, Kyle*, Computable properties of decomposable and completely decomposable groups

*Tan, Kuo-Chiang*, Codes for square-tiled surfaces

*Yao, Jinghua*, Existence, stability and bifurcation problems in continuum thermodynamics

*Zhong, Ping*, Regularities for distributions of free multiplicative Brownian motion and free multiplicative convolution semigroups

## Indiana University-Purdue University Indianapolis (2)

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*Harsy, Amanda*, Locally compact property A groups

*Lin, Qun*, A jackknife empirical likelihood approach to goodness of fit U-statistic testing with side information

## Purdue University (30)

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*Alfaro-Murillo, Jorge*, An epidemiological model structured by time since last infection

*Allen, Mark*, Thin free boundary problems

*Banerjee, Agnid*, Normalized $p$-Laplacian evolution: Boundary behavior of nonnegative solutions of fully nonlinear parabolic equations, gradient bounds for $p$-harmonic systems with vanishing Neumann (Dirichlet) data in a convex domain

*Barone, Salvador*, Some quantitative results in real algebraic geometry

*Cao, Shuhao*, The a posteriori error estimation in finite element method for the $H(\mathrm{curl})$ problems

*Fuchs, Urs*, Pseudoholomorphic curves in symplectic and contact geometry and their application in dynamics

*He, Ying*, Efficient spectral-element methods for acoustic scattering and related problems

*Hora, Raphael*, Scattering theory on asymptotic hyperbolic manifolds

*Huang, Shanshan*, Signal/image registration via polynomial system solution method and the Pascal triangle of a discrete image

*Imberti, David*, Methods for increasing domains of convergence in iterative linear system solvers

*Kim, Yeansu*, $L$-functions from Langlands-Shahidi method for GSpin groups and the generic Arthur $L$-packet conjecture

*Li, Jing*, Efficient estimation of failure probability

*Nguyen, Lan*, Rees algebras of linearly presented ideals

*Ni, Lichen*, $C^1$-continuous spectral elements and time integration algorithms

*Qiu, Lingyun*, Inverse boundary value problems for time-harmonic waves: Conditional stability and iterative reconstruction

*Ramachandran, Kousik*, Asymptotic behavior of positive harmonic functions in certain unbounded domains

*Shi, Wenhui*, Parabolic problems with thin free boundaries

*Tran, Dat*, Direct images as Hilbert fields and their curvatures

*Wang, Jin*, Sub-Riemannian heat kernels on model spaces and curvature-dimension inequalities on contact manifolds

*Zhang, Xuejing*, Some aspects of stochastic differential equation driven by fractional Brownian motion

DEPARTMENT OF STATISTICS

*Chang, Ching-Yun*, Cost-effective and accurate protein quantification for large-scale targeted proteomics

*Davidson, Allison*, A study of the tenability of Polya urn schemes

*DePalma, Glen*, Disk diffusion breakpoint determination using a Bayesian nonparametric variation of the errors-in-variables model

*Hu, Juan*, Optimal low rank model for multivariate spatial data

*Liu, Cheng*, Non-parameter spatial models

*Nisen, Jeffrey*, Statistical estimation of jump-diffusion models via optimal thresholding

*Srivastava, Sanvesh*, A framework for practical Bayesian analysis of high-dimensional genomic data

*Wu, Han*, Statistical models for gene and transcripts quantification and identification using RNA-Seq

*Yu, Danni*, Estimation of variation of high-throughput molecular biological experiments with small sample size

*Yun, Hyokun*, Doubly separable models and distributed parameter estimation

## University of Notre Dame (9)

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*Hao, Wenrui*, Homotopy method for nonlienear partial differential equaiton

*Li, Chunlei*, Computational modeling of microtubule instability

*Lioi, Josh*, Advancements in the modeling of blood clot formation

DEPARTMENT OF MATHEMATICS

*Chen, Xiaoyang*, Curvature and Riemannian submersions

*John, Harvey*, Around Palais' covering homotopy theorem

*Lin, Yueh-Ju*, Connected sum construction of constant $Q$-curvature manifolds in higher dimensions

*Liu, Han*, A plane rotational map with Chebyshev-like dynamics

*Ocasio Gonzalez, Victor*, Computability in the class of real closed fields

*Poulios, Georgios*, Peterzil-Steinhorn subgroups of real algebraic groups

# IOWA

## Iowa State University (40)

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*Albashrawi, Saleh*, Second order characteristic based schemes for chemotaxis system

*Basnet, Man*, On modified $l_1$-minimization problems in compressed sensing

*Erickson, Craig*, Sign patterns that require eventual exponential nonnegativity

*Failing, David*, Commutative, idempotent groupoids and the constraint satisfaction problem

*Hao, Yiping*, Computation and analysis of evolutionary game dynamics

*Osborne, Steven*, Cospectral bipartite graphs for the normalized Laplacian

*Pryporov, Maksym*, Gaussian beam methods for the Schrödinger equation with periodic potentials and strictly hyperbolic systems

*Seol, Young Soo*, Random walks in a sparse random environment

*Wang, Chi-Jen*, Analysis of discrete reaction-diffusion equations for autocatalysis and continuum diffusion equations for transport

*Wang, Jing*, Modeling of the interplay between single-file diffusion and reaction conversion in mesoporous systems

*Warnberg, Nathan*, Positive semidefinite propagation time

Department of Statistics

*Abell, Caitlyn Elizabeth*, Evaluation of litters per sow per year as a means to reduce non-productive sow days in commercial swine breeding herds and its association with other economically important traits

*Blythe, Derek Charles*, An investigation of viral fitness using statistical and computer models of equine infectious anemia virus infection

*Bramer, Lisa Marie*, Methods for modeling and forecasting wind characteristics

*Du, Chuanlong*, Modeling, inference, and clustering for equivalence classes of 3-D orientations

*Ghosh, Subhomoy*, Topics in stochastic growth models

*He, Ru*, Structure learning in Bayesian networks and session analysis of people search within a professional social network

*Hildreth, Laura Ann*, Residual analysis for structural equation modeling

*Hobbs, Jonathan Michael*, Characterizing diurnal and interannual variability in the atmosphere through physical and stochastic models

*Hoeksema, Amy Beth*, Statistical methods for the forensic analysis of stratiated tool marks

*Hsu, Yu-Yi*, Reducing parameter estimation bias for data with missing values using simulation extrapolation

*Kim, Eunice Jungeun*, Hotspot detection and a nonstationary process variance function estimation

*Le, Dai-Trang*, Applying item response theory modeling in educational research

*Li, Jun*, Two sample interference for high dimensional data and nonparametric variable selection for census data

*Li, Yang*, Non-parametric and semiparametric estimation of spatial covariance function

*Lin, Hui*, Statistical methods in disease risk analysis, disease testing, and nutrition epidemiology

*Liu, Bin*, Estimating multiple treatment effects in two-phase observational data

*Liu, Jia*, Statistical inference for functions of the parameters of a linear mixed model

*Liu, Shiyao*, Statistical methods for extreme values and degradation analysis

*Loy, Adam M.*, Diagnostics for mixed/hierarchical linear models

*Majumder, Md Mahbubul Amin*, Investigations into visual statistical inference

*McKelvey, Mark Wesley*, Modifications to classification and regression trees to solve problems related to imperfect detection and dependence

*Riddles, Minsun Kim*, Propensity score adjusted method for missing data

*Shukla, Sachet Ashok*, Topics in cancer genomics

*Stanfill, Bryan Adams*, Statistical methods for random rotations

*Vendettuoli, Marie C*, Workflow tools for biological applications

*Xie, Yihui*, Dynamic graphics and reporting for statistics

*Yang, Shan*, Estimation under stochastic differential equations

*Yang, Shu*, Fractional imputation method of handling missed data and spatial statistics

*Zhou, Wen*, Some Bayesian and multivariate analysis methods in statistical machine learning and applications

## University of Iowa (18)

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*Abiva, Jeannine Therese*, Learning the association of multiple inputs in recurrent networks

*Krines, Mark*, On the probabilistic modeling of consistency for iterated positional election procedures

*Padberg, Mary Therese Zeithaml*, Software for modeling protein-bound DNA: Determining a geometric structure consistent with known topological data

*Sheng, Qiwei*, Some approximations to radiative transfer equation and their applications

*Yang, Fan*, Asymptotics for risk measure of extreme risks

Department of Biostatistics

*Carter, Knute D*, Best-subset model selection based on multitudinal assessments of likelihood improvements

*Johnson, Amy M*, Modeling time series data with semi-reflective boundaries

*Yin, Jun*, Bayesian statistical modeling of epidemics and the contact networks that transmit them

Department of Mathematics

*Benson, Katherine*, On radio labeling of diameter $N-2$ and caterpillar graphs

*Brooks, Susan*, The geometry and topology of wide ribbons

*Florescu, Alina*, Reduced $\tau_n$-factorization in $Z$ and $tau_n$-factorizations in $N$

*Goertzen, Corissa*, Operations on infinite $x$ infinite matrices, and their use in dynamics and spectral theory

*Jones, Garrett*, Modeling knotted proteins with tangles

*Mooney, Christopher*, Generalized factorization in commutative rings with zero-divisors

*Niedzialomski, Amanda*, Consecutive radio labelings and the Cartesian product of graphs

*Teff, Nicholas*, The Hessenberg representation

*Wolf, Travis*, Coisometric extensions

Department of Statistics and Actuarial Science

*Chang, Shu-Ching*, Antedependence models for skewed continuous longitudinal data

# KANSAS

## Kansas State University (6)

Department of Mathematics

*Bischof, Bryan*, Deformations of differential operators

*DeSilva, Dilum*, Lind-Lehmer constant for groups of the form $Z_p^n$

Department of Statistics

*Ramirez, Girly*, Variable selection and prediction in sparse ultra high dimensional additive models

*Richardson, Troy*, Treatment heterogeneity and potential outcomes in linear mixed effects models

*Serasinghe, Roshan*, Individual mediating effects and the concept of terminal measures data

*Xiang, Sijia*, Semiparametric mixture models

## University of Kansas (3)

Department of Mathematics

*Console, Alexander*, Limit domains in several complex variables

*Harnett, Daniel*, Central limit theorems for some symmetric stochastic integrals

*Zhang, Mingji*, Dynamics of Poisson-Nernst-Planck system and applications to ionic channels

## Wichita State University (2)

Department of Mathematics, Statistics, and Physics

*Al-Shutnawi, Basma*, On convergence sets of formal power series

*Ryan, Justin*, Geometry of horizontal bundles and connections

# KENTUCKY

## University of Kentucky (13)

Department of Mathematics

*Akman, Murat*, On the dimension of a certain measure arising from a quasilinear elliptic pde

*Dailey, Megan*, Relative perturbation theory for diagonally dominant matrices

*Gier, Megan*, Eigenvalue multiplicities of the Hodge Laplacian on coexact 2-forms for generic metrics on 5-manifolds

*Gunturkun, Sema*, Homogenous Gorenstein ideals and Boij-Soderberg decompositions

*Hines, Clinton*, Spin cobordism and wedge quasitoric manifolds

*Huang, Tao*, Regularity and uniqueness of some geometric heat flows and its applications

*Kremer, Ray*, Homological algebra with filtered modules

*Monday, Casey*, A characterization of serve classes of reflective modules over a complete local Noetherian ring

*Ozbek, Furuzan*, Subfunctors of extension functors

*Sturgeon, Stephen*, Boij-Soderberg decompositions, cellular resolutions, and polytopes

DEPARTMENT OF STATISTICS

*Feng, Limin*, James-Stein type compound estimation of multiple mean response functions and their derivatives

*Xi, Jing*, Polytopes arising from binary mutlti-way contingency tables and characteristic imsets for Bayesian networks

*Zhang, Xiang*, Analysis of spatial data

### University of Louisville (2)

DEPARTMENT OF MATHEMATICS

*Kodippuli Thanthillage Dona, Rasitha Rangani Jayasekare*, Mixture of Poisson distributions to model discrete stock price changes

*Wang, Chunwei*, A stage structured delayed reaction-diffusion model for competition between two species

## LOUISIANA

### LSU Health Science Center, New Orleans (3)

DEPARTMENT OF BIOSTATISTICS

*Berken, Jennifer*, A study of type I and type II error rates of accepted and novel analysis methods through the development of an automated method to simulate comet assay images

*Beyl, Robbie*, Accuracy of $p$-values for inverse prediction in multi-category settings

*Du, Roufei*, Functional profiling of next-generation sequencing

### Louisiana State University, Baton Rouge (6)

DEPARTMENT OF MATHEMATICS

*Blanton, Jacob*, Reformulations for control systems and optimization problems with impulses

*Dribus, Benjamin*, On the infinitesimal theory of Chow groups

*Eakins, Evan*, Constructive aspects of Kochen's theorem on $p$-adic closures

*Latin, Ladorian*, A semigroup/Laplace transform approach to approximating flows

*McGuire, Trevor*, Combinatorial free resolutions of ideals with monomial and binomial generators

*Peng, Yun*, Ito formula and Girsanov theorem on a new Ito integral

### Louisiana Technology University (4)

PROGRAM OF MATHEMATICS AND STATISTICS

*Bracey, Scarlett*, Modeling and control of nanoparticle bloodstream concentration for tumor therapies

*Han, Fei*, Numerical simulation of hydrogen absorption/desorption processes in cylindrical metal-hydrogen reactors for hydrogen storage

*Shi, Liwei*, A mathematical model and numerical method for thermoelectric DNA sequencing

*Wang, Yifan*, Numerical solutions for problems with complex physics in complex geometry

### Tulane University (2)

DEPARTMENT OF MATHEMATICS

*Luo, Qingyang*, Integrated analysis of clinical and longitudinal genomic data

*Xiang, Tian*, Global dynamics of the local and nonlocal Patlak-Keller-Segel chemotaxis system

### University of Louisiana at Lafayette (4)

DEPARTMENT OF MATHEMATICS

*Delcambre, Mark*, Finite difference schemes for a structured model of mycobacterium marinum

*LeBlanc, Richard L.*, Baer and Rickart properties in modules and an associated radical

*Muniswamy, Sowmya*, Analytical and numerical approach to Caputo fractional differential equations via generalized iterative schemes with applications

*Wang, Yi*, Analysis and numerical schemes for certain structured population models

## MARYLAND

### Johns Hopkins University, Bloomberg School of Public Health (4)

DEPARTMENT OF BIOSTATISTICS

*Krall, Jenna*, Statistical methods for linking the chemical composition of particulate matter to health outcomes

*Maas, Paige*, Synthesizing data sources to develop and update risk models

*Shou, Haochang*, Statistical methods for structured multilevel functional data: Estimation and reliability

*Wei, Yingying*, Integrative statistical models for genomic signal detection

### Johns Hopkins University, Baltimore (10)

DEPARTMENT OF APPLIED MATHEMATICS AND STATISTICS

*Adali, Sancar*, Joint optimization of fidelity and commensurability for manifold alignment and graph matching

*Qin, Yichen*, Robust inference via Lq-likelihood

*Sussman, Daniel*, Foundations of adjacency spectral embedding

*Wang, Qi*, Optimization with discrete simultaneous perturbation stochastic approximation using noisy loss function measurements

*Zheng, Fang*, Algebraic approaches for constructing multi-D wavelets

DEPARTMENT OF MATHEMATICS

*Chen, Xuehua*, An improvement on eigenfunction restriction estimates for compact boundaryless Riemannian manifolds with nonpositive sectional curvature

*Karami, Arash*, Zeros of random Reinhardt polynomials

*Shao, Peng*, Sobolev resolvent estimates of the Laplace-Beltrami operator on compact Riemannian manifolds

*Sinclair, Duncan*, Heat kernels on Riemannian polyhedra and heat flows into NPC manifolds

*Xiao, Ling*, Flow problems in hyperbolic space

### University of Maryland, Baltimore County (7)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Ayyala, Deepak Nag*, High dimensional time series: Mean vector testing and testing for autocorrelation matrices

*Cornwell, David*, Amplified quantum transforms

*Jacobs, Justin*, Nonparametric Bayesian density estimation on Riemannian manifolds

*Mbodj, Malick*, Ellipsoidal tolerance regions and simultaneous tolerance intervals for some multivariate normal population

*Raim, Andrew*, Computational methods in finite mixtures using approximate information and regression limited to the mixture mean

*Trott, David*, Top heavy and special Bishop-Phelps cones, Lyapunov rank, and related topics

*Zimmer, Zachary*, Tolerance intervals under some discrete models, zero-inflated models and mixture models

## University of Maryland, College Park (16)

DEPARTMENT OF APPLIED MATHEMATICS, STATISTICS, AND SCIENTIFIC COMPUTATION

*Andrews, Travis*, Frame multiplication theory for vector-valued harmonic analysis

*Ballew, Joshua*, Mathematical topics in fluid-particle interaction

*Blagg, David*, Unramified extensions of the cyclotomic $\mathbb{Z}_2$-extension of $\mathbb{Q}(\sqrt{d}, i)$

*Cloninger, Alexander*, Exploiting data-dependent structure for improving sensor acquisition and integration

*Doster, Timothy*, Harmonic analysis inspired data fusion with applications in remote sensing

*Drombosky, Tyler*, Geodynamic simulations using the fast multipole boundary element method

*Meng, Tong*, Two price economy in continuous time and its applications in finance

*Motesharrei, Safa*, Minimal models of human-nature interaction

*Otarola Pasten, Enrique*, A PDE approach to numerical fractional diffusion

*Patrick, Carlos*, Surface tension free boundary problems: Formulation, optimal control, and numerics

*Rajapakse, Vinodh*, Data representation for learning and information fusion in bioinformatics

*Skinner, Michael*, An efficient method for radiation hydrodynamics in models of feedback-regulated star formation

*Sotiris, Ekaterina*, Outlier modeling for spatial Gaussian random fields

*Tsai, Wan-Yu*, Lift of the trivial representation to a nonlinear cover

*Wickman, Clare*, An optimal transport approach to some problems in frame theory

*Yu, Wei-Hsuan*, Spherical two-distance sets and related topics in harmonic analysis

# MASSACHUSETTS

## Boston University (9)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Benes, Gregory*, Stability of multi-solutions in the TODA model and torus canards in neuroscience models

*Cuzzocreo, Daniel*, Dynamical invariants and parameter space structures for rational maps

*Fitzgibbon, Elizabeth*, Rational maps: The structure of Julia sets from accessible Mandelbrot sets

*Gonzalez Ramirez, Laura*, Existence and stability of traveling waves in a biologically constrained model of seizure wave propagation

*Liu, Chong*, Functional principal component and factor analysis of spatially correlated data

*Nikolaev, Nikolay*, Some methods for robust inference in econometric factor models and in machine learning

*Viles, Weston*, Network data analysis

*Ward, Brandon*, Observables in the BC system

*Zelinsky, Joshua*, Variations on the Artin primitive root conjecture

## Brandeis University (4)

DEPARTMENT OF MATHEMATICS

*Fang, Yu*, Automorphic construction of units in a totally real field

*Hermes, Stephen*, Higher homotopy structures of Ginzburg algebras

*Ostroff, Jonah*, Counting connected digraphs with gradings

*Zhang, Yurong*, Iwasawa main conjecture for Eisenstein series $E_{k+z,2,1,\epsilon}$

## Harvard U, School of Public Health (14)

BIOSTATISTICS DEPARTMENT

*Alexeeff, Stacey*, Measurement error in environmental exposures: Statistical implications for spatial air pollution models and gene environment interaction tests

*Barnett, Ian*, SNP-set tests for sequencing and genome-wide association studies

*Bind, Marie-Abele*, Statistical methods to investigate the role of genetic and epigenetic mechanisms in air pollution and temperature health effects

*Braun, Danielle*, Statistical methods to adjust for measurement error in risk prediction models and observational studies

*Cudhea, Frederick*, A novel method for modeling hierarchical developmental toxicity data and calculating joint risk BMDs based on the Plackett-Dale distribution

*Dai, Wei*, Robust approaches to marker identification and evaluation for risk assessment

*Dean, Natalie Exner*, Surveillance methods for monitoring HIV incidence and drug resistance

*Huang, Norman*, Graph-based support vector machines for patient response prediction using pathway and gene expression data

*Lin, Xinyi*, Statistical methods for high-dimensional data in genetic epidemiology

*Meyer, Mark*, Function-on-function regression with public health applications

*Mitchell, Shira*, Capture-recapture estimation for conflict data and hierarchical models for program impact evaluation

*Mukherjee, Rajarshi*, Statistical inference for high dimensional problems

*Rader, Kevin*, Methods for analyzing survival and binary data in complex surveys

*Sathirapongsasuti, Jarupon Fah*, Post-genomic approaches to personalized medicine: Applicaitons in exome sequencing, microbiome, and COPD

## Harvard University (16)

DEPARTMENT OF MATHEMATICS

*Antonakoudis, Stergios*, The complex geometry of Teichmüller space

*Daemi, Aliakbar*, Symmetric spaces and knot invariants from gauge theory

*Diao, Hansheng*, The eigencurve is proper

*Ivrii, Oleg*, The geometry of the Weil-Petersson metric in complex dynamics

*Le Hung, Bao Viet*, Modularity of some elliptic curves over totally real fields

*Pflueger, Nathan*, Regeneration of elliptic chains with exceptional linear series

*Raskin, Samuel*, Chiral principal series categories

*Woolf, Matthew*, Relative Jacobeans of linear systems

*Zhou, Jie*, Arithmetic properties of moduli spaces and topological string partition functions of some Calabi-Yau threefolds

DEPARTMENT OF STATISTICS

*Bischof, Jonathan*, Interpretable and scalable Bayesian models for advertising and text

*Espinosa, Valeria*, A Bayesian perspective on factorial experiments using potential outcomes

*Guo, Lei*, Bayesian biclustering on discrete data: Variable selection methods

*Han, Simeng*, Statistical methods for aggregation of indirect information

*Kelly, Joseph*, Advances in the normal-normal hierarchical model

*Sabbaghi, Arman*, Dilemmas in design: From Neyman and Fisher to 3D printing

*Watson, David*, Complications in causal inference: Incorporating information observed after treatment is assigned

## Massachusetts Institute of Technology (18)

DEPARTMENT OF MATHEMATICS

*Batson, Joshua*, Obstructions to slicing knots and splitting links

*Bélanger-Rioux, Rosalie*, Compressed absorbing conditions for the Helmholtz equation

*Cesnavicius, Kestutis*, Selmer groups as flat cohomology groups

*Culler, Lucas*, The blowup formula for higher rank Donaldson invariants

*Deckelbaum, Alan*, The structure of auctions: Optimality and efficiency

*DeFranco, Mario*, The unramified principal series at $p$-adic groups the Bessel function

*Dubbs, Alexander*, Beta-ensembles with covariance

*Jackson-Hanen, David*, Symplectic cohomology of contractible surfaces

*Keating, Ailsa Macgregor*, Symplectic properties of Milnor fibres

*Ketover, Daniel*, Min-max minimal surfaces is 3-manifolds

*Lesieutre, John*, Negative answers to some positivity questions

*Lieson, Mark*, New statistical genetic methods for elucidating the history and evolution of human populations

*Liu, Tiankai*, On planar rational cuspidal curves

*Minton, Gregory*, Computer-assisted proofs in geometry and physics

*Oza, Anand*, A trajectory equation for walking droplets: Hydrodynamic pilot-wave theory

*Park, Jennifer*, Effective Chabauty for symmetric powers of curves

*Tsymbaliuk, Oleksandr*, The affine Yangian of $\mathfrak{gl}_1$ and the infinitesimal Cherednik algebras

*Tucker, George*, Statistical methods to infer biological interactions

## Northeastern University (6)

DEPARTMENT OF MATHEMATICS

*Appel, Andrea*, Monodromy theorems in the affine setting

*Duke, Andrew*, Cube-like regular incidence complexes

*Kesir, Mustafa*, A mathematical model of redox/methylation metabolism in human neuronal cells

*Veetel, Bindu*, On the regularity of solutions to the Beltrami equation in the plane

*Yang, Yaping*, Three contributions to topology, algebraic geometry and representation theory: Homological finiteness of abelian covers, algebraic elliptic cohomology theory and monodromy theorems in the elliptic setting

*Zhao, Gufang*, Deprived category and cohomology of resolution of singularities: Examples from representation theory

## Tufts University (3)

DEPARTMENT OF MATHEMATICS

*Friedhoff, Stephanie*, Design and analysis of multigrid methods for parabolic problems

*Hao, Ning*, Moving from matrix to tensor-based analysis and algorithms for applications in imaging science and beyond

*Offerman, Christine*, Multi-temporal wave equations on flat and compact symmetric spaces

## University of Massachusetts, Amherst (13)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Aiello, Domenico*, Galois theory of iterated morphisms on reducible elliptic curves and Abelian surfaces with real multiplication

*Chen, Dechang*, Isoperimetric inequality and area growth of surfaces with bounded mean curvature

*Friedlander, Holley*, Twisted Weyl group multiple Dirichlet series over the rational function field

*Gassert, Thomas*, Prime decomposition in iterated towers and discriminant formulae

*Herr, Daniel*, Open books on contact three orbifolds

*Kazanova, Anna*, Degenerations of Godeaux surfaces and exceptional vector bundles

*Koonz, Jennifer*, Properties of singular Schubert varieties

*Li, Jingran*, Conditional Gaussian fluctuations and refined asymptotics of the spin in the phase-coexistence region

*Li, Kai*, Discrete parity-time symmetric nonlinear Schrödinger lattices

*Mohr, Luke*, Martingale central limit theorem and nonuniformly hyperbolic systems

*Rana, Julie*, Boundary divisors in the moduli space of stable quintic surfaces

*Yan, Dong*, Dark-bright solitons and vortices in Bose-Einstein condensates

DEPARTMENT OF PUBLIC HEALTH BIOSTATISTICS

*Yu, Shuli*, Evaluating predictors of individual dietary intake latent values under different mixed models

## Worcester Polytechnic Institute (1)

MATHEMATICAL SCIENCES DEPARTMENT

*Zheltukhin, Sergey*, Preferred frequencies for coupling of seismic waves and vibrating tall buildings

# MICHIGAN

## Central Michigan University (6)

DEPARTMENT OF MATHEMATICS

*Al-Aqtash, Raid*, On generating new families of distributions using the logit function

*Aljarrah, Mohammad*, System of continuous distributions generated from quantile functions

*Alzaghal, Ahmad*, Families of exponentiated generalized distributions: Properties and applications

*Gautam, Yadu*, A novel approach of imputing summary statistics for genome-wide association study

*Loszewski, Cleland*, The symplectic volume of the ribbon graph complex

*Wijetunge, Tharanga*, The role of advance student response system-perspectives of the preservice secondary mathematics teachers

## Michigan State University (11)

DEPARTMENT OF MATHEMATICS

*Bao, Lian Zhang*, Some properties of backward forward parabolic equations from population dynamics

*Giambrone, Adam*, A combinatorial approach to knot theory: Volume bounds for hyperbolic semi-adequate link complements

*Jones, Jaylan*, Development of a fast and accurate time stepping scheme for the functionalized Cahn-Hillard equation and application to a graphics processing unit

*Krcatovich, David*, The reduced knot Floer complex

*Maridakis, Manousos*, The concentration principle

*Reznikov, Aleksandr*, Weighted norm inequalities for Calderón-Zygmund operators

*Shadrach, Richard*, Integral models of certain PEL Shimura varieties with $\Gamma_1(p)$-type level structure

DEPARTMENT OF STATISTICS AND PROBABILITY

*Cheng, Dan*, The excursion probability of Gaussian and asymptotically Gaussian random fields

*Kang, Lening*, The excursion probability of Gaussian and asymptotically Gaussian random fields

*Wu, Cen*, High dimensional statistical methods for gene-environment interactions

*Zhang, Kai*, Model selection and forecasting for periodic time series

## Michigan Technological University (2)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Al-Habahbeh, Abdallah*, Simulations of Newtonian and non-Newtonian flows in deformable tubes

*Kumari, Sapna*, Identification of genes controlling biological processes and pathways through statistical analysis and network reconstruction

## Oakland University (2)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Connolly, Robert D.*, Matching preclusion and conditional matching preclusion problems for the folder Petersen cube

*Hayman, Thomas J.*, Facet-inducing inequalities of the convex hull of integer solutions of application-driven structures of multiple all-different predicates

## University of Michigan (37)

DEPARTMENT OF MATHEMATICS

*Abram, William*, Equivariant complex cobordism

*Altschul, Samuel*, Endoscopy for nilpotent orbits of $G_2$

*Beichman, Jennifer*, Nonstandard dispersive estimates and linearized water waves

*Bosler, Peter*, Particle methods for geophysical flow on the sphere

*Brooks, Ernest*, Generalized Heegner cycles, Shimura curves, and special values of $p$-adic $L$-functions

*Chung, Sohhyun*, The impact of Volcker rule on bank profits and default probabilities

*Clader, Emily*, The Landau-Ginzburg/Calabi-Yau correspondence for certain complete intersections

*Ford, Nicolas*, Geometric shifts and positroid varieties

*Gignac, William*, Equidistribution of preimages in nonarchimedean dynamics

*Gu, Huaiying*, Value-at-Risk (VaR) and dynamic portfolio selection

*Henry, Shawn*, Classifying topoi and preservation of higher order logic by geometric morphisms

*Huang, Yu-Jui*, Topics in stochastic control with applications to finance

*Kim, Jae Kyoung*, Mathematical modeling and analysis of biological clocks within cells

*Lapan, Sara*, On the existence of attracting domains for maps tangent to the identity

*Lee, Seung Jin*, Centrally symmetric polytopes with many faces

*Meyer, Jeffrey*, On the totally geodesic commensurability spectrum of an arithmetic locally symmetric space

*Mueller, Alexander*, Applications of generalized Fermat varieties to zeta functions of Artin-Schreier curves

*Priddis, Nathan*, A Landau-Ginzburg/Calabi-Yau correspondence for the mirror quintic

*Reyes, Kristopher-Roy*, Large scale kinetic Monte Carlo simulations: Theory, implementation and applications

*Roberts, Joseph*, Steady and self-similar solutions to two-dimensional hyperbolic conservation laws

*Rosen, Julian*, The artithmetic of multiple harmonic sums

*Sadiq, Burhan*, Finite difference methods, Hermit interpolation and Quasi-Uniform Spectral Schemes (QUSS)

*Scherr, Zachary*, Rational polynomial Pell equations

*Scott, Geoffrey*, Torus actions and singularities in symplectic geometry

*Shearer, Paul*, Separable inverse problems, blind deconvolution, and stray light correction for extreme ultraviolet solar images

*Shen, Yefeng*, Gromov-Witten theory of elliptic orbifold projective lines

*Shoemaker, Mark*, A mirror theorem for the mirror quintic

*Watkins, Jordan*, The higher rank rigidity theorem for manifolds with no focal points

*Wu, Jingchen*, Some problems in stochastic control theory related to inventory management and coarsening

*Zhu, Zhixian*, Topics in singularities and jet schemes

DEPARTMENT OF STATISTICS

*Cheng, Jie*, Mixed and covariate dependent graphical models

*Mallik, Atul*, Topics on threshold estimation, multistage methods and random fields

*Mankad, Shawn*, Statistical techniques for the exploratory analysis of structured three-way and dynamic network data

*Mukherjee, Ashin*, Topics on reduced rank methods for multivariate regression

*Park, Yeo Jung*, New methods for discovering hidden dependence and for assessing the possible influence of unobserved variables

*Sales, Adam*, New perspectives on regression adjustment in causal inference, with applications to educational program evaluation

*Zhang, Zhanyang*, Predictive models and calibration analysis in large-scale computational studies

## Wayne State University (8)

DEPARTMENT OF MATHEMATICS

*Fan, Li*, DG and HDG for curved structures

*Hashemi, Araz*, Adaptive stochastic systems: Estimation, filtering, and noise attenuation

*Talafh, Yousef*, Two-time scale systems in continuous time with regime switching and their applications

*Tilson, Sean*, Power operations in the Künneth and $C_2$-equivariant Adams spectral sequences with applications

*Tran, Nghia*, Full stability in optimization

*Xiao, Yayuan*, Discrete Littlewood-Paley-Stein theory and Wolff potentials on homogeneous spaces and multiparameter Hardy spaces

*Zhao, Guangliang*, Properties of nonlinear randomly switching dynamic systems: Mean-field models and feedback controls for stabilization

*Zhu, Jiuyi*, Qualitative properties of solutions of fully nonlinear equations and overdetermined problems

## Western Michigan University (10)

DEPARTMENT OF MATHEMATICS

*Andrews, Eric*, On Eulerian irregularity and decompositions in graphs

*Arnold, David*, Classifying spaces of symmetric groups and wreath products

*Atanga, Napthalin*, Elementary school teachers' use of curricular resources for lesson design and enactment

*Bulut, Alper*, Lie loops associated with $GL(\mathscr{H})$, $\mathscr{H}$ a separable infinite dimensional Hilbert space

*Edson, Alden J.*, A deeply digital instructional unit on binomial distributions and statistical inference: A design experiment

*Goss, Joshua*, A method for assessing and describing the informal inferential reasoning of middle school students

*Houck, Julienne (Julie)*, A pattern in the Lusternik-Schnirelmann category of rational spaces

*Kipka, Robert*, Mathematical methods of analysis for control and dynamic optimization problems on manifolds

DEPARTMENT OF STATISTICS

*Burgos, Jaime*, Multivariate autoregressive time series using Schweppe weighted Wilcoxon estimates

*Jelsema, Casey*, Estimates and inference for spatial and spatio-temporal mixed effects models

# MINNESOTA

## University of Minnesota-Twin Cities (19)

DIVISION OF BIOSTATISTICS, SCHOOL OF PUBLIC HEALTH

*Austin, Erin*, Penalized regression and its applications to genetics and genomics

*Quick, Harrison*, Spatiotemporal gradient modeling with applications

*Zhang, Yiwei*, Two topics in association analysis of DNA sequencing data

SCHOOL OF MATHEMATICS

*Chang, Ching-Hao*, Isotopy of nodal symplectic spheres in rational manifolds

*Chen, Haoran*, A dynamic model of polyeclectrolyte gels

*Feng, Hao*, On three-dimensional Navier-Stokes equations with axi-symmetric vortex rings as initial vorticity

*Huang, Jia*, 0-Hecke algebra actions on flags, polynomials, and Stanley-Reisner rings

*Miller, Alexander*, Reflection arrangements and ribbon representations

*Nie, Xiaolan*, Complex Monge-Ampère equations and Chern-Ricci flow on Hermitian manifolds

*Oestreicher, Samantha*, Forced oscillators with dynamic Hopf bifurcations and applications to Paleoclimate

*Thompson, Robert*, Applications of moving frames to group foliation of differential equations
*Williams, Nathan*, Cataland

SCHOOL OF STATISTICS

*Ding, Shanshan*, Sufficient dimension reduction for complex data structures
*Kang, Yicheng*, Edge detection and image restoration of blurred noisy images using jump regression analysis
*Mai, Qing*, Variable selection in high-dimensional classification
*Price, Bradley*, Ridge fusion in statistical learning
*Sherwood, Benjamin*, Quantile regression model selection
*Zhang, Xin*, Envelopes for efficient multivariate parameter estimation
*Zimmerman, Patrick*, Survey sampling and multiple stratifications

# MISSISSIPPI

## Mississippi State University (3)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Bhoumik, Soumya*, On the automorphism groups of almost circulant graphs and digraphs
*Kalappattil, Lakshmi*, Classes of singular nonlinear eigenvalue problems with semipositone structure
*Williams, Jahmario*, Positive radial solutions for $p$-Laplacian singular boundary value problems

## University of Mississippi (3)

DEPARTMENT OF MATHEMATICS

*Curry, Jamye*, Rank-based two sample tests under a general alternative
*Putnam, Bette*, The characterization of graphs with small bicycle spectrum
*Turnage-Butterbaugh, Caroline*, Moments of products of $L$-functions

## University of Southern Mississippi (1)

DEPARTMENT OF MATHEMATICS

*Cenek, Eowyn*, Iterative solvers for large, dense matrices

# MISSOURI

## Missouri University of Science and Technology (1)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Zeng, Bilin*, Sparse group sufficient dimension reduction and covariance cumulative slicing estimation

## St Louis University (2)

DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

*Lloyd-Hepburn, Tanya*, Ricci flow on anti-self-adjoint naturally reductive homogeneous spaces
*Pedigo, Mark*, The lower central series of the free nilpotent groups of finite rank

## University of Missouri-Columbia (15)

DEPARTMENT OF MATHEMATICS

*Alhazaa, Khalifa*, Counter examples on Strichartz's inequalities
*Brigham, Daniel*, Quasi-metric geometry
*Cahill, Jameson*, Frames and projections
*Nicholas, Jacob*, Limit of many molecules dynamics with rigorous macroscopic results
*Soumya, Sanyal*, Irrational behavior of algebraic discrete valuations
*Valerian, Yurov*, Stability estimates for strongly continuous semigroups and partly parabolic reaction diffusion equations
*Vinh, Pham*, Generating sequences of valuations and applications

DEPARTMENT OF STATISTICS

*Dey, Rima*, Random set models for growth with applications to nowcasting
*Gladish, Daniel*, Spatio-temporal models with time-varying spatial model error for enviromental processes
*Kim, Sungwook*, Optimal experimental design under a multivariate Weibull function
*Le, Tri Minh*, The formal definition of reference priors under a general class of divergence
*Qi, Yue*, Equivalence test of high dimensional microarray data
*Wang, Haiying*, Design and analysis of a new bounded log-linear regression model
*Wu, Guohui*, Flexible Bayesian hierarchical models for discrete-valued spatio-temporal data
*Yang, Wen-Hsi*, Hierarchical nonlinear, multivariate, and spatially-dependent time-frequency functional models

## University of Missouri-Kansas City (1)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Wu, Wei*, Sequential designs and application in software engineering

## University of Missouri-St Louis (1)

DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

*Li, Lihua*, Basis function approaches for two dimensional Cochlear models

## Washington University (2)

DEPARTMENT OF MATHEMATICS

*Deng, Wei*, Four generated rank 2 arithmetically Cohen-Macaulay bundles on general sextic surfaces

PRESTON M. GREEN DEPARTMENT OF ELECTRICIAL AND SYSTEM ENGINEERING

*Zlotnik, Anatoly*, Optimal control and synchronization of dynamic ensemble systems

# MONTANA

## Montana State University (7)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Akapame, Sydney*, Robust design strategies for nonlinear models using genetic algorithms
*Bouwman, Andrew*, L-cuts for genus 2 translation surfaces
*Moreland, Heather*, Traveling waves in pancreatic islets
*Nordey, Kim*, Investigating viable arguments: Preservice secondary teachers' ability to construct arguments and critique the reasoning of others
*Nowack, Shane*, Niche character in a temporally varying environment
*Thorenson, Jennifer*, Discontinuous Galerkin finite element method for stimulation of a transcription process method
*Vsevolozhskaya, Olga*, Combining functions and the closure principle for performing follow-up tests in functional analysis of variance

## University of Montana - Missoula (3)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Chih, Tien*, Abstracted primal-dual affine programming
*Kogan, Clark*, Accuracy assessment in Bayesian forecasting linear and nonlinear models
*Severino, Michael*, Digraphs and homomorphisms: Core, construction, and colorings

# NEBRASKA

## University of Nebraska-Lincoln (17)

DEPARTMENT OF MATHEMATICS

*Auch, Tanner*, Development and application of difference and fractional calculus on discrete time scales
*Awasthi, Pushp Raj*, Boundary value problems for discrete fractional equations
*Carraher, James*, Results on edge-colored grahs and pancyclicity

*Clark, Thomas*, An applied functional and numerical analysis of a 3-D fluid-structure interactive PDE

*Corwin, Nathan*, Embedding and nonembedding results for R. Thompson's group $V$ and related groups

*DeVries, Melanie*, Unknotting moves of virtual knots

*Denkert, Annika*, Results on containments and resurgences with a focus on ideals of points in the plane

*Gibbons, Courtney*, Decompositions of Betti diagrams

*Haymaker, Kathryn*, Combinatorial and algebraic coding techniques for flash memorage storage

*Johnson, Ashley*, Closure and homological properties of (auto)stackable groups

*Nolting, Ben*, Random search models of foraging behavior: Theory, simulation, and observation

*Pei, Pei*, Well-posedness and stability of a semilinear Mindlin-Timoshenko plate model

*Yu, Xuan*, Geometric study of the category of matrix factorizations

DEPARTMENT OF STATISTICS

*Black, Michael*, Informative retesting for hierarchical group testing

*Claassen, Elizabeth*, A reduced bias method of estimating variance components in generalized linear mixed models

*Montesinos-Lopez, Osval*, Design and analysis of multistage group testing surveys with application to detecting and estimating prevalence of transgenic corn in Mexico

*Wichman, Christopher*, A test for detecting changes in closed networks based on the number of communications between nodes

# NEVADA

## University of Nevada, Las Vegas (1)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Zhou, Shilei*, Time-dependent random effect Poisson random field model for polymorphism within and between two related species

# NEW HAMPSHIRE

## Dartmouth College (10)

DEPARTMENT OF MATHEMATICS

*Archer, Kassie*, Permutations realized by signed shifts

*Bloom, Jonathan*, Pattern avoiding permutations and rook placements

*Crytser, Danny*, Traces on graph algebras

*Engberg, Zebediah*, The arithmetic of cyclic subgroups

*Gillaspy, Elizabeth*, $K$-theory for twisted groupoid $C^*$-algebras

*Hamaker, Zachary*, Bijective combinatorics of reduced decompositions

*Kinnaird, Katherine*, Aligned hierarchies for sequential data

*Komarov, Natalie*, Capture time in variants of cops and robbers games

*LaLonde, Scott*, Nuclearity and exactness for groupoid crossed product $C^*$-algebras

*Levi, Asa*, Refocussing and virtual Legendrian knots

## University of New Hampshire (5)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Chen, Yanni*, Function spaces based on symmetric norms

*Kim, Hyung*, Developing mathematics teachers' pedagogical identity in the classroom context

*Laflamme, Eric*, Extreme value theory: Applications to estimation of stochastic traffic capacity and statistical downscaling of precipitation extremes

*Lu, Kewei*, On Fan's adaptive Neyman tests for two testing problems in time series analysis

*Morena, Matthew*, Mutual stabilization of chaotic systems through entangled cupolets

# NEW JERSEY

## New Jersey Institute of Technology (8)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Akcay, Zeynep*, Dynamics of phase locking in neuronal networks in the presence of synaptic plasticity

*Aunsri, Nattapol*, Particle filtering for frequency estimation from acoustic time-series in dispersive media

*Bandha, Sonia*, Data analysis and simulation for warranties and golf handicaps

*Lin, Tao*, Inverse methods for sound speed estimation in the ocean

*Lynch, Gavin*, The control of the false discovery rate under structured hypotheses

*Nganguia, Herve*, Electro-deformation of a moving boundary: A drop interface and a lipid bilayer membrane

*Qiu, Zhiying*, FWER controlling procedures for testing multiple hypotheses with hierarchical structure and applications in clinical trials

*Zhang, Yang*, A modeling study of the history-dependence of conduction delay in unmyelinated axons

## Princeton University (18)

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*Alexeev, Boris*, An assortment of results in combinatorics and compressed sensing

*An, Xinliang*, Formation of trapped surfaces in general relativity

*McBreen, Michael*, Quantum cohomology of hypertoric varieties and geometric representations of Yangians

*Park, YoungHan*, Hyperbolic hypergeometric monodromy groups and geometric finiteness

*Pollack, Aaron*, Rankin-Selberg integrals in many complex variables and Rankin-Selberg integrals associated to non-unique models

*Reichert, Nicholas*, Some results on a fully nonlinear equation in conformal geometry

*Ruth, Sam*, A bound on the average rank of $j$-invariant zero elliptic curves

*Seed, Cotton*, Higher differentials on Khovanov homology

*Shenfeld, Daniel*, Abelianization of stable envelopes in symplectic resolutions

*Sosoe, Philippe*, Fluctuation bounds for two disordered models

*Sun, Hongbin*, On closed hyperbolic 3-manifolds and pseudo-Anosov maps

*Tu, Yu-Chao*, Étale covering between resolution of isolated singularities and Gaffney-Lazarsfeld theorem for homogeneous spaces

*Zhan, Bohua*, Combinatorial methods in bordered Heegaard Floer homology

PROGRAM IN APPLIED COMPUTATIONAL MATHEMATICS

*Arrubarrena, Jesus Puente*, Distances and algorithms to compare sets of shapes for automated biological morphometrics

*Cheng, Xiuyuan*, Random matrices in high-dimensional data analysis

*Kihun, Nam*, Stochastic differential equations with superlinear drivers

*Kim, Ilhee*, On containment relations in directed graphs

*Wang, Lanhui*, Robust synchronization and 3D reconstruction from Cryo-EM images

## Rutgers School of Public Health (1)

DEPARTMENT OF BIOSTATISTICS

*Li, Shiansong*, Bayesian statistical analysis in a phase II clinical trial with survival endpoint in patients with B-cell chronic lymphocytic leukemia

## Rutgers, The State University of New Jersey New Brunswick (22)

DEPARTMENT OF STATISTICS AND BIOSTATISTICS

*Dai, Dong*, Bayesian model averaging with exponential least squares loss

*Li, Wentao*, Importance sampling methods with multiple sampling distributions

*Liu, Kezhen*, Statistical applications to cardiovascular disease research

*Liu, Yufan*, Recent advances in computer experiment modelng

*Tang, Ning*, Robust gene set analysis and robust gene expression

*Yang, Guang*, Meta-analysis through combining confidence distributions

*Yi, Lan*, Biomarker discovery for microarray data by enriched methods, stochastic approximation, and mixed models

MATHEMATICS DEPARTMENT

*Bate, Brandon*, Automorphic distributions and the functional equation for the standard $L$-function for $G_2$

*Craig, Katy*, The exponential formula for the Wasserstein metric

*Datar, Ved*, Canonical Kahler metrics with cone singularities

*Fu, Knight*, Slice filtration and torsion theory in motivic cohomology

*Li, Zhan*, On the birationality of toric double mirrors

*McRae, Robert*, Integral forms for certain classes of vertex operator algebras and their modules

*Naqvi, Yusra*, A product formula for certain Littlewood-Richardson coefficients for Jack and Macdonald polynomials

*Osorio, Eduardo*, Finite-difference and finite-element solution of boundary value and obstacle problems for the elliptic Heston operator

*Pal, Susovan*, Boundary and Holder regularity of Douady-Earle extensions and eigenvalues of Laplace operators acting on Riemann surfaces

*Ravikumar, Vijay*, Triple intersection numbers for isotropic Grassmannians

*Sadowski, Christopher*, On the structure of principal subspaces of standard modules for affine Lie algebras of type A

*Samuel, Matthew*, The Leibniz formula for divided difference operators associated to Kac-Moody root systems

*Wang, Hui*, On a Hardy type inequality and a singular Sturm-Liouville equation

*Wang, Yu*, Curvature and statistics

*Yang, Jinwei*, Some results in the representation theory of strongly graded vertex algebras

## Rutgers, The State University of New Jersey Newark (2)

DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

*Aggarwal, Monica*, On Rota-Baxter Nijenhuis TD-algebra

*Kapadia, Hetal*, Deligne pairings and discriminants of algebraic varieties

## Stevens Institute of Technology (1)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Zhang, Yi Di*, Groups and ordinals by automata

# NEW MEXICO

## New Mexico State University, Las Cruces (3)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Jaradat, Imad*, Equivariant triviality of proper $\mathbb{G}_a$-actions on $\mathbb{A}^4_Y$

*Tchamna Kouna, Simplice*, The ideal completion of a Noetherian local domain

*Yang, Taewon*, The logic of bundles

## University of New Mexico (9)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Byrne, Martha*, Changes in student proving skills and attitudes following a cooperative learning seminar

*Castaneda, Candelario*, Sasakian geometry on lens space bundles over Riemann surfaces

*Hattab, Mohammad*, A survey of lack-of-fit tests based on sums of ordered residuals

*Heras-Llanos, Alfonso*, Arithmetic differential subgroups of $GL_n$

*Madrid Ramirez, Pedro*, Modeling the mechanical response of polycrystalline thin films

*Terry, Jason*, Quantification of stability in systems of nonlinear ordinary differential equations

*Toropu, Cristina*, ABC theorems in the functional case

*Wang, Xueqin*, Bayesian partially ordered probit and logit models with an application to course redesign

*White, Bryan*, Star operations and numerical semigroup rings

# NEW YORK

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DEPARTMENT OF MATHEMATICS AND SCIENCE

*Jaafari, Fatima Zohra*, Adaptive methods for estimating the mean of finite population

*Kaminski, Jackie*, Classification of inductively factored gain-graphic arrangments of hyperplanes

*McCulloch, Ryan*, The Chermak-Delgado lattice of finite groups

*Minemyer, Barry*, Isometric embeddings of polyhedra

*Ruiz, Amanda*, Realization spaces of phased matroids

*Wu, Xiaolei*, Farrell-Jones conjecture for the solvable Baumslag-Solitar groups

## Clarkson University (7)

DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

*Fowler, Michael*, Generalized uncertainty quantification for linear inverse problems in X-ray imaging

*Hu, Wenjin*, Quantitative investigation of the technologies that support Cloud computing

*Huddy, Stanley R.*, The effects of coupling delay on the dynamics and synchronization of small oscillator networks

*Kramer, Sean*, Oceanographic modeling with hyperspectral satellite data

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*Mihajlovikj, Vidoje*, Hybrid layout of metabolic networks

*Opperman, Michael*, Graphs with perfect state transfer in quantum walks

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*Chen, Tianle*, Statistical modeling and statistical learning for disease classification and prediction

*Ciarleglio, Adam*, On wavelet-based procedures for scalar-on-function regression

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*Jia, Xiaoyu*, Two-stage continual reassessment method and patient heterogeneity for dose-finding studies

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DEPARTMENT OF MATHEMATICS

*Clarkson, Corrin*, Three manifold mutations detected by Heegaard Floer homology

*Collins, Tristan*, Canonical metrics in Sasakian geometry

*Hanselman, Jonathan*, Bordered Heegaard Floer homology and graph manifolds

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*Pan, Xuanyu*, Rational normal curves on complete intersections

*Puskas, Anna*, Demazure-Lusztig operations and metaplectic Whittaker functions on covers of the general linear group

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*Waldron, Alex*, Self-duality and singularities in the Yang-Mills flow

*Wang, Ye-Kai*, A spacetime Alexandrov theorem

*Whitehead, Ian*, Multiple Dirichlet series for affine Weyl groups

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*Xue, Hang*, The geometry and arithmetic of genus four curves

DEPARTMENT OF STATISTICS

*Dorie, Vincent*, Mixed methods for mixed models

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*Liu, Ying*, Kernel-based association measures

*Pickov, Radka*, Generalized volatility-stabilized processes

*Teravainen, Timothy*, Semiparametric estimation of a gaptime-associated hazard function

*Vinkovskaya, Ekaterina*, A point process model for the dynamics of limit order books

*Zhang, Stephanie*, Statistical inference and experimental design for Q-matrix based cognitive diagnosis models

## Cornell University (20)

CENTER FOR APPLIED MATHEMATICS

*Chacon, Adam*, Eikonal equations: New two-scale algorithnms and error analysis

*Cochran, Amy*, Ultrasound-based measurements for diagnosing medical disorders

*Iams, Sarah*, Characterizing mosquito flight through measurement and simulation

*Montovan, Kathryn*, Cooperation in a repetitive and often mistaken world

*Mull-Osborn, Alexander*, Portfolio optimization in incomplete markets in the presence of asset price bubbles

*Nguyen, Duc*, A study of the tail measure and its applications in risk modeling

*Nishimura, Joel*, Designing pulse coupled oscillators to synchronize

DEPARTMENT OF MATHEMATICS

*Alonso, Juan*, Graphs of free groups and their measure equivalence

*Bessonov, Mariya*, Probabilistic models for population dynamics

*El Fassy Fihry, Youssef*, Graded Cherednik algebra and quasi-invariant differential forms

*Jones, Kristine*, Generic initial ideas of locally Cohen-Macaulay space curves

*Miller, Robyn*, Symbolic dynamics on billiard flow in isosceles triangles

*Radu, Remus*, Topological models for hyperbolic and semi-parabolic complex Hénon maps

*Tanase, Raluca*, Hénon maps, discrete groups and continuity of Julia sets

*Tran, Hung*, Aspects of the Ricci flow

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*Zheng, Tianyi*, Random walks on some classes of solvable groups

DEPARTMENT OF STATISTICAL SCIENCES

*Gomez Tecuapelta, Inder*, Asymptotic inference for locally stationary processes

*Li, James*, Tensor (multidimensional array) decomposition, regression and software for statistics and machine learning

*Schneider, Matthew*, Three papers on time series forecasting and data privacy statistics

## Graduate Center, City University of New York (9)

PHD PROGRAM IN MATHEMATICS

*Chen, Anbo*, Involutions in arithmetic geometry

*Chen, Tao*, Geometric characterization and dynamics of entire functions

*Ji, Ran*, The asymptotic Dirichlet problems on manifolds with unbounded negative curvature

*Lam, Ha*, Exploring platform (semi)groups for non-commutative key-exchange protocols

*Singh, Satyanand*, Special representations, Nathanson's lambda seqences and explicit bounds

*Susse, Timothy*, Stable commutator length in amalgamated free products

*Suzzi Valli, Robert*, Non-simple closed geodesics on 2-orbifolds

*Terlecky, Peter*, Lean, green, and lifetime maximizing mobile sensor deployment on a barrier

*Thrall, Louis*, Trees, prisms, and a Quillen model structure on prismatic sets

## New York University Polytechnic School of Engineering (3)

DEPARTMENT OF MATHEMATICS

*Medina, Luciano*, Chern-Simons equations arising in a quantum Hall effect

*Yarmish, Jason*, Elliptic Brunn-Minkowski theory: Generalizations of the Brunn-Minkowski inequalities

*Zhu, Guangxian*, Minkowski problems and affine isoperimetric inequalities

## New York University, Courant Institute (27)

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*Chou, Evan*, Beta-duals of frames and applications to problems in quantization

*Cohen, Naftali*, What drives the Brewer-Dobson circulation? Wave mean-flow theories, interactions between resolved and unresolved waves and the limits of downward control

*Elgindi, Tarek*, Some results on the Euler equations for incompressible flow

*Harel, Matan*, The localization phase transition in random geometric graphs with too many edges

*Heilman, Steven*, Gaussian isoperimetry for multiple sets

*Jhang, An-Sheng*, Dilute suspensions of length-changing rods in various domains

*Jorgensen, Jens*, Zero transmission in acoustic membrains

*Kim, Hongsik*, Optimal execution under liquidity constraints

*Kim, Yungkwon*, The effect of inhibitory feedback in small neural network

*Koehler, Lukas*, On the Shafarevich conjecture

*Krishnan, Arjun*, Variational formula for the time-constant of first-passage percolation

*Li, Sean*, Quantitative embeddability of groups

*Li, Xichen*, Teleconnections between the tropical oceans and Antarctic climate

*Lin, Ling*, Mathematical study of milestoning

*May, Sandra*, Embedded boundary of methods for flow in complex geometries

*Mehrdad, Behzad*, Random sparse groups with a given degree sequence

*Portegies, Jacobus (Jim)*, Spectral geometry with applications to data analysis

*Ryals, Brian*, Synchronization and phase-locking of coupled oscillators

*Salas-Boni, Rebeca*, Dimensionality reduction rotations and hypothesis testing via classifier performance

*Schioppa, Andrea*, Derivations and Alberti representations

*Sen, Sanchayan*, On random minimal spanning trees and inhomogeneous random graphs

*Stern, Alon*, Ocean heat delivery mechanisms beneath Arctic ice shelves

*Thomas, Jordan*, Contraction techniques in the hyperbolicity of surfaces of general type

*Trigila, Giulio*, A mesh free method for optimal transport and a binary integer linear programming solver

*Yang, Dingyu*, A complete theory of Kuranishi structures and the polyfold-Kuranishi correspondence

*Zhu, Bo*, Gauss-Newton-Metropolis with backup strategy

*Zhu, Kangping*, Two problems in applications of PDE

## New York University, Stern School of Business (1)

IOMS-STATISTICS GROUP

*Flynn, Cheryl*, Prediction for data-dependent regularization and consistent biclustering

## Rensselaer Polytechnic Institute (6)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Bai, Lijie*, On convex quadratic programs with linear complementary constraints

*DelBene, Kevin*, Mathematical modeling of wildfire dynamics

*Fayton, Joseph*, Estimation of geoacoustic parameters of marine mud

*Lee, Timothy*, Approximations and improvements to semidefinite relaxations of optimization problems

*Newman, Andrew*, Low dimensional tools for the study of turbulence with applications to wind energy

*Sikorski, Kajetan*, Pairwise approximations in micro-swimming

## Stony Brook University (40)

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*Cai, Ying*, A stochastic segmentation model for recurrent copy number alterations in grouped array-CGH data

*Chai, Yikang*, Modeling intra-day markets with an application of risk management and optimal order execution

*Chen, Yu-Chuan*, Canonical forest

*Dong, Xu*, New development on market microstructure and macrostructure: Patterns of U.S. high frequency data and a unified factor model framework

*Goswami, Mayank*, Computing Teichmüller maps and applications of conformal geometry to sensor networks

*Guo, Tongfei*, Scalable particle and mesh algorithms for elliptic components of multiphase problems

*Jia, Tengjie*, Structures and algorithms for covariance estimates with application to finance

*Jiang, Tao*, Mathematical modeling of G-protein-coupled receptor signaling pathways

*Kim, Hyoungkeun*, Models and numerical algorithms for hydrodynamics with atomic processes and high energy density applications

*Kim, Joo-Won*, Throat intersection in pore networks and application to reactive flow

*Kurosaki, Tetsuo*, Risk measurement and management in the global markets with the tempered stable distributions

*Lihm, Jayon*, Mixture modeling of next-generation sequencing data and its applications to genotyping and estimating genotype frequency

*Lu, Tianyu*, The Chinese equity risk factor model based on heavy tailed distributions, and its application in risk management and portfolio optimization

*Panok, Lena*, The dynamical basis for the decanalization of gap gene expression in Kruppel mutant embryos

*Ray, Navamita*, High-order surface reconstruction and its applications for surface integrals and surface remeshing

*Shao, Pengyuan*, Approximation of long memory process by short memory process—with application to option valuation

*Song, Yuzhou*, Structure breaks in PCA with applications in finance

*Tsao, Angela*, Partial hedging under stochastic interest rate

*Tsuchida, Naoshi*, Application of risk analysis based on advanced probabilistic models

*Wu, Jie*, Novel computational methodology for detecting and quantifying alternative splicing from RNA-seq data

*Yu, Han*, Application of machine learning to decision support systems

*Yu, Yang*, Essays in financial econometrics

*Yuan, Eting*, A study of two optimal planning problems in smart grid

*Zhang, Lina*, Studies of hydrodynamic processes in alternative magneto-inertial fusion devices

*Zhang, Ruiqi*, Modeling the effect of sequencing error

*Zhou, Yijie*, Front tracking method with high-order enhancement and its application in two-phase micromixing of incompressible viscous fluids

DEPARTMENT OF MATHEMATICS

*Aleyasin, Seyed Ali*, The space of Kähler potentials on singular and non-compact manifolds

*Cha, Ye Sle*, Deformations of axially symmetric initial data and the angular momentum-mass inequality

*D'Mello, Shane*, Real rational curves of low degree

*Gallardo, Patricio*, On the moduli space of quintic surfaces

*Gianniotis, Panagiotis*, The Ricci flow on manifolds with boundary

*Gindi, Steven*, Holomorphic twistor spaces and bihermitian geometry

*Kim, Inyoung*, Almost-Kähler anti-self-dual metrics

*Lee, Jaepil*, Computation of bordered Floer invariant of $(2, 2n)$ torus link

*Li, Long*, On the uniqueness of singular Kaehler-Einstein metrics

*Meneses, Claudio*, Kähler potentials on the moduli space of stable parabolic bundles over the Riemann sphere

*Smith, Lloyd*, The Kontsevich space of rational curves on cyclic covers of projective space

*Wen, Jun*, Shintani zeta functions and Weyl group multiple Dirichlet series

*Wroten, Matthew*, The eventual Gaussian distribution of self-intersection numbers on closed surfaces

*Zhang, Xin*, On the local-global principle for Appolonian-3 circle packings

## Syracuse University (3)

DEPARTMENT OF MATHEMATICS

*Entner, Jeremy*, Methods of nonparametric multivariate ranking and selection

*Kamau, Leonard*, Technology adoption in secondary mathematics teaching in Kenya: An explanatory mixed methods study

*Zhao, Liang*, Filter-based multiscale entropy analysis of complex physiological time series

## The University at Albany, SUNY (5)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Chagouel, Isaak*, The geometry of the projective joint spectrum and the commutativity of self-adjoint operators

*Lubovsky, Arthur*, Alcove models for Hall-Littlewood polynomials and affine crystals

*Qin, Yueshi*, On Rudin's pathological submodules over bidisk

*Smitas, Daniel*, Lipschitz estimates on weakly pseudoconvex domains

*Wolf-Christensen, Lauren*, The essential spectra of Toeplitz operators on Hardy spaces and the Riemann-Hilbert problem

## University at Buffalo-SUNY (8)

DEPARTMENT OF BIOSTATISTICS

*Dong, Tuochuan*, Three and more class diagnostic studies

*Imam, Netsanet*, High dimensional factor analysis for predictive modeling, gene discovery, and genetic risk assessment

*Lai, Wei*, Quantile function methods with applications to robust estimation

*Tao, Ge*, Novel likelihood type statistical procedures based on frequentist, Bayesian and hybrid techniques applied to health related studies

*Yan, Li*, Selected topics in statistical methods for DNA microarray analysis

*Yin, Jingjing*, Topics in ROC analysis: Joint inference, combination of multiple biomarkers, and confidence bands

DEPARTMENT OF MATHEMATICS

*Corrigan-Salter, Bruce*, Rigidification of homotopy algebras over finite product sketches

*Johns, Bryan*, The theory of 2-functions

## University of Rochester (9)

DEPARTMENT OF BIOSTATISTICS AND COMPUTATIONAL BIOLOGY

*Chen, Juo-Fan*, State space models and differential equations for dynamic gene regulatory network identification

*Evans, Katie*, Extensions to model-based clustering for mixed-type data: A new model framework, variable selection, and outlier identification

*Wu, Pan*, A new class of structural functional response models for causal inference and mediation analysis

*Yang, Hui*, Model selection and model averaging for longitudinal data with applications in personalized medicine

*Yu, Yao*, Single-index model with application in estimation of ODE and gene regulatory network

DEPARTMENT OF MATHEMATICS

*Creek, Matthew*, Large-data global well-posedness for the $(1+2)$-dimensional equivariant Faddeev model

*Gratton, Chad*, ABC implies Bang-Zsigmondy results in arithmetic dynamics

*Larson, Donald*, The Adams-Novikov $E_2$-term for Behrens' spectrum $Q(2)$ at the prime 3

*Stafa, Mentor*, On polyhedral products and spaces of commuting elements in Lie groups

# NORTH CAROLINA

## Duke University (18)

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*Crosskey, Miles*, Atlas simulation: A numerical scheme for approximating multiscale diffusions embedded in high dimensions

*Lawley, Sean*, Stochastic switching in evolution equations

*Li, Junchi*, Axelrod's model in two dimensions

*O'Neill, Christopher*, Monoid congruences, binomial ideals, and their decompositions

*Ryu, Hwayeon*, Feedback-mediated dynamics in the kidney: Mathematical modeling and stochastic analysis

*Sgouralis, Ioannis*, A dynamical nephrovascular model of renal autoregulation

*Xu, Hangjun*, Uniformly area expanding flows in spacetimes

DEPARTMENT OF STATISTICAL SCIENCE

*Au, Timothy*, Topics in computational advertising

*Challis, Christopher*, Bayesian structural phylogenetics

*Heard, Daniel*, Statistical inference utilizing agent-based models

*Leininger, Thomas*, Bayesian analysis of spatial point patterns

*Li, Yingbo*, Bayesian hierarchical models for model choice

*Montagna, Silvia*, On Bayesian analyses of functional regression, correlated functional data and non-homogeneous computer models

*Murray, Jared*, Some recent advances in non- and semiparametric Bayesian modeling with copulas, mixtures, and latent variables

*Petralia, Francesca*, Structured Bayesian learning through mixture models

*Terres, Maria*, Multivariate spatial process gradients with environmental applications

*Wang, Jianyu*, Bayesian modeling and adaptive Monte Carlo with geophysics applications

*Yang, Yun*, Nonparametric Bayes for big data

## North Carolina State University (43)

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*Ball, Kenneth*, Structure preserving integrators and Hamel's equations

*Benim, Robert*, Isomorphy classes of involutions on $\mathrm{SO}(n,k,\beta)$ and $\mathrm{SP}(2n,k)$ where $n>2$

*Brenneman, Kathryn*, Lifting $k$-involutions from the root system to the Lie algebra

*Comer, Matthew*, Error correction for symbolic and hybrid symbolic-numeric sparse interpolation algorithms

*Costolanski, Anne*, Numerical simulation of resonant tunneling devices described by the Wigner-Poisson equations

*Cousins, William*, Boundary conditions and uncertainty quantification for hemodynamics

*Crook, Susan*, Automated shape recognition and curve matching using discrete invariants

*Elamami, Elgaddafi*, Augmented strategies for 3D elliptic interface problems with piecewise constant discontinuous coefficients

*Fleisher, Daniel*, Wakimoto modules, FMS Bosonization and integrable hierarchies

*Hendrix, Angelean*, Modeling the effects of androgens on hormonal regulation of the menstrual cycle

*Hutchens, John*, Isomorphy classes of $k$-involutions of algebraic groups of type $G_2$ and $F_4$

*Jiang, Ming*, Traveling wave solutions, periodic and chaotic solutions of a PDE approximation of coupled Chua's circuits

*Kenz, Zachary*, Stenosis-driven acoustic wave propagation in biotissue: Modeling and the inverse problem

*Law, Shirley*, Combinatorial realization of certain Hopf algebras of pattern-avoiding permutations

*Margolskee, Alison*, A whole life model of the human menstrual cycle

*Maroncelli, Daniel*, Existence of solutions to nonlinear boundary value problems at higher dimensional resonance

*McMahan, Jerry*, Control applications for smart systems exhibiting hysteretic nonlinearities

*Norbrothen, Emma*, On classifying of the double cosets $H_k\backslash G_k/H_k$ of $\mathrm{SL}(2,k)$

*Pendleton, Terrance*, An analytical and numerical study of a class of nonlinear evolutionary PDEs

*Rehm, Keri*, Multiscale modeling of plant growth combining enzyme kinetics and whole plant dynamics and experimental design applications

*Sawyer, Megan*, Compartmentalizing the sunlight vitamin: Physiologically based pharmacokinetic modeling and vitamin D

*Schwartz, Nathaniel*, On the classification of $k$-involutions of $\mathrm{SL}(n,k)$ and $\mathrm{O}(n,k)$ over fields of characteristic 2

*Smith, Erick*, SAR imaging through the Earth's ionosphere

*Willert, Jeffrey*, Hybrid deterministic/Monte Carlo methods for solving the neutron transport equation and $k$-eigenvalue problem

*Williams, Nakeya*, Mathematical modeling of cardiovascular dynamics during head-up tilt

*Wright, Justin*, Periodic dynamical systems of population models

DEPARTMENT OF STATISTICS

*Bai, Xiaofei*, Doubly-robust estimators in observational studies with and without a stratified sub-sample

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*Beeman, Jennifer*, Assessing understanding of sampling distributions and differences in learning amongst different learning styles

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*Che, Ronglin*, Statistical methods in genetic association studies and a genetic risk score for predictive modeling of disease risk: From gene discovery to translation

*Davenport, Clemontina*, Semiparametric regression models for interacting covariates

*Geng, Yuan*, Flexible statistical learning methods for survival data: Risk protection and optimal treatment decision

*Kao, Yi-Min*, Advances in nonparametric Bayesian methods for clustering and classification

*Kong, Dehan*, Penalized regression methods with application to domain selection and outlier detection

*Shen, Weining*, Adaptive Bayesian function estimation

*Torres, Pedro*, Quantile regression for repeated responses measured with error

*Vock, Laura*, Bridge models and variable selection methods for spatial data

*Wang, Liwei*, Nonparametric models for longitudinal data using Bernstein polynomial sieve

*Wang, Xin*, Statistical methods for gene-gene interaction: Detections and classifications

*Wilson, Thomas*, Advances in Bayesian methods for high-dimensional environmental data

*Zhang, Aijing*, Statistical methods for assessment of biosimilarity on follow-on biologics

*Zhao, Guolin*, Assessing complex genetic effects using variance component based marker-set methods

## University of North Carolina at Chapel Hill (36)

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*Brownstein, Naomi*, Analysis of time-to-event data, intermediate phenotypes, and sparse factors in the OPPERA study

*Chung, Wonil*, Bayesian parametric and nonparametric methods for multiple QTL mapping and SNP-set analysis

*Ha, Min Jin*, Graphical models for high dimensional genomic data

*Hyun, Noorie*, Analysis of interval censored data using a longitudinal biomarker

*Khondker, Zakaria*, Bayesian penalized methods for high-dimensional data

*Lin, Ja-an*, Statistical methods for imaging genetic data

*Liu, Lan*, Casual inference with interference

*Song, Guochen*, Enrollment and stopping rules for managing toxicity in phase II oncology trials with delayed outcome

*Urrutia, Eugene*, The statistical analysis of genetic sequencing and rare variant association studies

*Zhang, Yi (Ian)*, Statistical methods for evaluating the diagnostic accuracy of incomplete multiple tests

*Zhao, Ni*, Kernel machine methods for analysis of genomic data from different sources

*Zhou, Jing*, Nonparametric Bayes methods for high dimensional data and group sequential design for longitudinal trials

*Zhu, Ruoqing*, Three-based methods for survival analysis and high-dimensional data

*Zou, Baiming*, Robust and efficient statistical inference for clustered observational data in comparative effectiveness research

DEPARTMENT OF MATHEMATICS

*Abel, Michael*, Virtual crossings and filtrations in linkk homology

*Allman, Justin*, K-classes of quiver cycles, Grothendieck polynomials and iterated residues

*Chen, Shengqian*, Dynamics of continuously stratified and two-layer incompressible Euler fluids and internal waves

*Fovargue, Daniel*, Multiscale and multiphysics computational models of processes in shock wave lithotripsy

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*Shi, Feng*, Modeling networks and dynamics in complex systems: From nanocomposites to opinion formation

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*Wang, Simi*, Modeling networks in nanocomposites and power grids

DEPARTMENT OF STATISTICS AND OPERATION RESEARCH

*Chaudhuri, Ritwik*, Non-Gaussian semistable distributions and their statistical applications

*Gong, Qi*, Stochastic models for order book dynamics

*Lee, Nelson*, Service center design and control problem

*Lee, Wonyul*, New statistical learning methods for multiple high dimensional datasets

*Sabourin, Jeremy*, LASSO based resample model averaging for genetics association studies

*Wang, Xuan*, The critical scaling window for dynamic random graph process

*Wei, Susan*, Latent supervised learning and DiProPerm

*Ye, Han*, Data-driven workforce management in call centers

## University of North Carolina at Charlotte (5)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Hounkanli, Kokouvi*, The center and cyclicity problems in a family of three dimensional polynomial systems of ordinary differential equations

*Liu, Yi*, Generalized quasi-likelihood ratio statistics for multivariate time-varying coefficient regression models

*Ray, Elijah*, A random hierarchical Laplacian

*Wang, Yonggang*, Generalized quasi-likelihood ratio tests for varying coefficients quantile regression models

*Wu, Li*, Consistent nonparametric test on nonlinear regression models with near-integrated covariates

# NORTH DAKOTA

## North Dakota State University, Fargo (3)

DEPARTMENT OF MATHEMATICS

*Abdullayev, Farhod*, Variational methods for polycrystal plasticity and related topics in partial differential equations

*Nasseh, Saeed*, DG homological algebra, properties of ring homomorphisms, and the generalized Auslander-Reiten conjecture

*Wicklein, Richard*, Codualizing modules and complexes

# OHIO

## Air Force Institute of Technology (4)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Geyer, Andrew*, Different formulations of the orthogonal array problem and their symmetries

*Greenwell, Brandon*, Topics in statistical calibration

*Gutman, Alex*, Construction, analysis, and data-driven augmentation of supersaturated designs

*Paek-Spidell, Gracie*, Analysis of heat partitioning during sliding contact at high speed and pressure

## Bowling Green State University (10)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Chen, Yanran*, Influence of correlation and missing data on sample size determination in mixed models

*Combs, Adam*, Bayesian model checking methods for dichotomous item response theory and testlet models

*Hasan, Abeer*, A study of skew t distribution with application

*Immormino, Nicholas*, Clean rings and clean group rings

*Kadel, Gokul*, Hypercyclic extensions of an operator on a Hilbert subspace with prescribed behaviors

*Lin, Yong*, A partitioning approach for the selection of the best treatment

*Ngunkeng, Grace*, Statistical analysis of skew normal distribution and its applications

*Pailden, Junvie*, Applications of empirical likelihood to zero-inflated data

*Paneru, Khyam*, Regression analysis for zero inflated population under complex sampling designs

*Son, Vladimir*, Multivariate population attributable hazard function for right-censored data

## Case Western Reserve University (5)

Department of Mathematics, Applied Mathematics and Statistics

*Arnold, Andrea*, Sequential Monte Carlo parameter estimation for differential equations

*Cheng, Yougan*, Computational models of brain energy metabolism at different scales

*Gassama, Edrissa*, Piezoelectric inverse problems with resonance data: A sequential Monte Carlo analysis

*Joseph, Charles*, Multi-scale modeling and analysis of options markets

*Volzer, Joseph*, An invariant embedding approach to domain decomposition

## Kent State University, Kent (6)

Department of Mathematical Sciences

*Braga, Bruno*, On the Borel complexity of some classes of Banach spaces

*Franca, Willian*, Commuting maps on some subsets that are not closed under addition

*Kim, Jaegil*, Duality phenomena and volume inequalities in convex geometry

*Montanaro, William*, Character degree graphs of almost simple groups

*Sass, Catherine*, Prime character degree graphs of solvable groups having diameter three

*Starvaggi, Patrick*, Exact distributions of sequential probability ratio tests

## Ohio State University, Columbus (36)

Department of Mathematics

*Acan, Huseyin*, An enumerative-probabilistic study of chord diagrams

*Christopherson, John Cory*, Ideals in the Stone-Cech compactification of a countable semigroup and some applications to ergodic theory and topological dynamics

*George, Jennifer*, TQFTs from quasi-Hopf algebras and group cocycles

*Gibbons, Aliska*, Automorphism groups of buildings contstructed via covering spaces

*Greene, Ryan*, The deformation theory of discrete reflection groups and projective structures

*Jia, Yuhan*, Numerical study of the KP solitons and higher order Miles theory of the mach reflection in shallow water

*Joecken, Kyle*, Dimension of virtually cyclic classifying spaces for certain geometric groups

*Kowalick, Ryan*, Discrete systolic inequalities

*Miller, Jason*, Okounkov bodies of Borel oribit closures in wonderful group compactifications

*Olmez, Fatih*, Sleep-wake transition dynamics and power-law fitting with an upper bound

*Ozcakir, Ozge*, Traveling wave solutions in a cylindrical pipe

*Park, Hyejin*, New asymptotic methods in the study of analytic differential and dynamical systems

*Perkins, Rudolph*, On special values of Pellarin's $L$-series

*Peterson, Nicholas*, On random $k$-out graphs with preferential attachment

*Poole, Daniel*, A study of random hypergraphs and directed graphs

*Rosenblatt, Heather*, Asymptotics and Borel summability: Applications to MHD, Boussinesq equations and rigorous Stokes constant calculations

*Son, Younghwan*, Some results on joint ergodicity, sets of recurrence and substitution and tiling systems

*Vutha, Amit*, Normal forms and unfoldings of singular strategy functions

*Waller, Bradley*, Properties of $p$-adic $C-k$ distributions

*Wiser, Justin*, Harmonic resonance dynamics of a periodically forced Hopf oscillator

Department of Statistics

*Bai, Shasha*, Inference on intraclass correlation coefficients arising in a general clustered repeated measures design

*Bradley, Jonathan*, Selection of predictors and estimators in spacial statistics

*Chen, Tian*, Judgement post-stratification with machine learning techniques: Adjusting for missing data in surveys and data mining

*Fan, Hang*, Estimation of species tree using approximate Bayesian computation

*Frazier, Marian*, Adaptive design for global fit of non-stationary surfaces

*Gao, Jinguo*, Rank regression in order restricted randomized designs

*Hinton, Alice*, Contributions to discriminant analysis of cross-sectional and longitudinal data with applications

*Kil, Siyoen*, Finding a targeted subgroup with efficacy for binary response with application for drug development

*Kim, Sungmin*, Community detection in directed networks and its application to analysis of social networks

*Leatherman, Erin*, Optimal predictive designs for experiments that involve computer simulators

*Liang, Zhiyu*, Eigen-analysis of kernel operators for nonlinear dimension reduction and discrimination

*Sampath, Srinath*, Analysis of agreement between two long ranked lists

*Sgambellone, Anthony*, Use of ranking information from unmeasured units in ranked set and judgements post stratified smaples

*Spade, David*, Investigating convergence of Markov chain Monte Carlo methods for Bayesian phylogenetic inference

*Sullivan, Danielle*, A hot deck imputation procedure for multiply imputing nonignorable missing data: The proxy pattern-mixture hot deck

*Thompson, Katherine*, Using ancestral information to search for quantitative trai loci in genome-wide association studies

## Ohio University, Athens (5)

Department of Mathematics

*Beal, Joshua*, Matching problems for stochastic processes

*Buckalew, Richard*, Mathematical models in cell cycle biology and pulmonary immunity

*Hoffman, Douglas*, A coloring theorem for inaccessible cardinals

*Malaikah, Khalid*, Laplacian growth: Interface evolution in a Hele-Shaw cell

*Mastromatteo, Joseph*, The subprojectivity and pure-subinjectivity domain of a module

## University of Cincinnati (8)

Department of Mathematical Sciences

*Guo, Wei*, A unified approach to data transformation and outlier detection using penalized assessment

*Kim, Woosuk*, Statistical inference on dual generalized order statistics for Burr type III distribution

*Li, Dandan*, On multiplicity adjustment in Bayesian variable selection

*Li, Qian*, Infinite mixture model based cluster analysis for gene expression data

*Ramaruban, Nadesan*, Commutative hyperalgebra

*Xiao, Yang*, A Bayesian subgroup analysis using an additive mixture model

*Zhang, Xiao*, Experiment design and reliability analysis of accelerated degradation test

*Zou, Yuanshu*, Robustifying a non-linear model using wavelets

# OKLAHOMA

## Oklahoma State University (7)

Department of Mathematics

*Chen, Lizhi*, Systolic freedom of 3-manifolds

*Kwon, Bo-hyun*, An algorithm to classify rational 3-tangles

*Mills, Melissa*, Case studies of instructional practices in proof-based mathematics lectures

*Regmi, Dipendra*, A study on the global regularity for two-dimensional magneto-hydro-dynamic and Boussinesq equations

*Tao, Lizheng*, 2D Boussinesq equations with logarithmically super-critical conditions

*Wescoatt, Benjamin*, An explanation of college students' problem solving behaviors while verifying trigonometric identities: A mixed methods case study

*Yamazaki, Kazuo*, On the existence and smoothness problem of the magneto-hydrodynamics system

## University of Oklahoma (5)

DEPARTMENT OF MATHEMATICS

*Herrera, Yoe*, Intersection numbers in a hyperbolic surface

*Lee, Misun*, Calculus instructors' ROGs in teaching low achieving students

*Li, Suyu*, Some sharp inequalities related to Moser-Trudinger-Onofri inequality

*Lynam, Matthew*, Extensional maps

*Thuong, Scott*, Classification, cobordism, and curvature of four-dimensional infra-solo manifolds

# OREGON

## Oregon State University (3)

DEPARTMENT OF MATHEMATICS

*Medina, Patricia*, Mathematical treatment and simulation of methane hydrates and adsorption models

DEPARTMENT OF STATISTICS

*Mi, Gu*, Statistical analysis of RNA sequencing count data

*Sun, Luna*, Statistical methods for serially correlated zero-inflated proportions

## University of Oregon (4)

DEPARTMENT OF MATHEMATICS

*Kloefkorn, Tyler*, On algebras associated to finite ranked posets and combinatorial topology

*Schultz, Patrick*, Algebraic weak factorization systems in double categories

*Stewart, Allen*, Motivic integral of K3 surfaces over a non-Archimedean field

*Sun, Michael*, The tracial Rokhlin property for countable discrete amenable group actions on nuclear tracially approximately divisible $C^*$-algebras

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## Carnegie Mellon University (13)

DEPARTMENT OF MATHEMATICAL SCIENCE

*Allen, Emily*, Combinatorial interpretations of generalizations of Catalan numbers and ballot numbers

*Boney, Will*, Advances in classification theory for abstract elementary classes

*Lambie-Hanson, Chris*, Covering matrices, squares, scales, and stationary reflection

*McKenney, Paul*, Forcing axioms and the rigidity of corona algebras

*Ouyang, Yuhui*, Numerical approximation of valuation equations incorporating stochastic volatility models

*Rute, Jason*, Topics in algorithmic randomness and computable analysis

DEPARTMENT OF STATISTICS

*Etchegaray Garcia, Beatriz*, Classification via auxiliary information: Formalism and application to classification of variable stars

*Izbicki, Rafael*, A spectral series approach to high-dimensional nonparametric inference

*Kent, Brian*, Level set trees for applied statistics

*Kurtz, Zachary*, Local log-linear models for capture-recapture

*VanHoudnos, Nathan*, The efficacy of the Hedges correction for unmodeled clustering, and its generalizations in practical settings

*Wu, Jionglin*, Statistical multi-coil MRI reconstruction

*Zeifman, Lubov*, A new parametric model for the point spread function and its application to Hubble space telescope data

## Drexel University (2)

DEPARTMENT OF MATHEMATICS

*Dalal, Avinash*, Quantum and affine Schubert calculus and Macdonald polynomials

*Parry, Daniel*, A polynomial variation of Meinardus' theorem

## Lehigh University (6)

DEPARTMENT OF MATHEMATICS

*Baker, Breeanne*, The $k$-fixed-endpoint path partition problem

*Garmirian, Patricia*, The central limit theorem and the estimation of the concentration of measure for fractional Brownian motion

*Haines, Christopher*, The relative advantage of knowing an initiation time or a mean time when estimating a parameter from an exponential distribution using type-II left censored date

*Halperin, Alexander*, Subdivisions with distance constraints in large graphs

*Ryan, Kathleen*, Degree sequences of edge-colored graphs in specified families and related problems

*Zhang, Yingying*, Geometric quantization of classical metrics on the moduli space of canonical metrics

## Pennsylvania State University (13)

DEPARTMENT OF MATHEMATICS

*Basu, Sankha*, A model of intuitionism based on Turing degrees

*Facchi, Giancarlo*, Optimal bidding in a limit order book

*Flynn, Ryan*, Quaternion algebras and elliptic curves over function fields of finite characteristic

*Han, Ke*, An analytical approach to sustainable transportation network design

*Ji, Xiang*, Deformation problems in Lie algebroids and extended Poisson geometry

*Katz, Matthew*, On the number of $A \times B$ quotient diagrams of integer partitions

*Le, Thinh*, Nonlocal exterior calculus on Riemannian manifolds

*Mayanskiy, Evgeny*, Asymptotic Mukai model of $M_6$

*Pathak, Noopur*, Computable aspects of measure theory

*Song, YanLi*, Geometric quantization, reduction and $k$-homology

*Wei, Deling*, Models of noncooperative games

*Yashinski, Allan*, Periodic cyclic homology and smooth deformations

*Yu, Shilin*, The Dolbeault DGA of a formal neighborhood

## Pennsylvania State University, University Park (9)

DEPARTMENT OF STATISTICS

*Kim, Seonjin*, Three essays on nonparametric inference for longitudinal data and time series data

*Li, Xiaoye*, Three essays on non-stationary time series

*Li, Yihan*, Methods in multiple testing and meta-analysis with applications to the analysis of genomic data

*Lou, Lejia*, Threeholded partial correlation approach for variable selection in linear models and partially linear models

*Nunes, Marcus*, Analysis of next-gen sequencing data with excess of zeroes

*Wang, Wei*, Performance criteria for control charts

*Woo, Yong Ming*, Optimization and statistical estimation for the post randomization method

*Zhang, Ying*, New models for conditional covariance matrix

*Zhu, Yeying*, Data-adaptive approaches to modeling propensity scores in causal inference problems

## Temple University (6)

DEPARTMENT OF MATHEMATICS

*Fan, Shimao*, Data-fitted generic macroscopic traffic flow models

*Gidelew, Getnet*, Harmonic analysis on combinatorial graphs

*Shank, Stephen*, Low-rank solution methods for large-scale linear matrix equations

DEPARTMENT OF STATISTICS

*Campbell, Kathleen*, Extension of Kendall's tau using rank-adapted SVD to identify correlation and factors among rankers and equivalence classes among ranked elements

*Halbert, Keith*, Estimation of probability of failure for damage-tolerant aerospace structures

*Xu, Yihuan*, Robust estimation of the parameters of $g$- and $h$-distributions, with application to outlier detection

## University of Pennsylvania (28)

APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE

*Han, Wei*, Predictable sequences and competing with strategies

*Liu, Xiaoxian*, A PDE-based method for optimizing solar cell performance

*Liu, Yang*, 3D image reconstruction from serial sections

*Yang, Fan*, Causal inference methods for addressing censoring by death and unmeasured confounding using instrumental variables

*Zhang, Xingtan*, A sharper ratio

DEPARTMENT OF MATHEMATICS

*Aditya, Surapaneni*, A constructible higher Riemann Hilbert correspondence

*Curry, Justin*, Sheaves, cosheaves and applications

*Ding, Shanshan*, A random walk in representations

*Jing, Taisong*, The strong CM lifting problem and the relabelling action on the equicharacteristic universal deformation space of formal groups over $F_p$

*Kelly, Tyler*, On Berglund-Hubsch-Krawitz mirror symmetry

*Korman, Eric*, Elliptic involutive structures and generalized Higgs algebroids

*Manion, Ryan*, Heterotic Chen-Ruan cohomology

*Mostert, Pieter*, Mixed zeta functions

*Nuchi, Haggai*, The Hopf fibrations are characterized by being fiberwise homogeneous

*Subramanian, Sneha*, Zeros, critical points and coefficients of random functions

*Tai, Matthew*, Family algebras and the isotypic components of $g \otimes g$

*Wen, Haomin*, Scattering and lens rigidity

*Yeroshkin, Dmytro*, Riemannian orbifolds with non-negative curvature

WHARTON STATISTICS DEPARTMENT

*Affandi, Raja Hafiz*, Learning, large-scale inference, and temporal modeling of determinantal point processes

*Ernst, Philip*, Multiple collection estimation of population size: A generalization of "capture-recapture"

*Fuki, Igar*, Bayesian aspects of classification procedures

*Goldstein, Alex*, Topics in tree-based methods

*Hong, Andrew*, Gaussian Markov random field models for surveillance error and geographic boundaries

*Kapelner, Adam*, Statistical analysis and design of crowdsourcing applications

*Pitkin, Emil*, Inference for approximating regression models

*Rising, Justin*, Advances in the theory of determinantal point processes

*Rodu, Jordan*, Spectral estimation of hidden Markov models

*Zubizarreta, José*, Optimal designs for observational studies using integer programming

## University of Pittsburgh (24)

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*Begum, Ferdouse*, GWAS meta-analysis: Methodology and application to human meiotic recombination

*Chang, Lun-Ching*, Issues in information integration of omics data: Microarray meta-analysis for candidate marker and module detection and genotype calling incorporating family information

*Chen, Yi-Fan*, Statistical issues in comparative effectiveness research

*Dong, Xinxin*, Topics in joint modeling of longitudinal biomarker, quality of lifetime, and survival data

*He, Fanyin*, Nonparametric MANOVA approaches for non-normal multivariate outcomes

*Lee, Ching-Wen*, Joint modeling with censored data and group-based trajectory clustering

*Ling, Yun*, Detection of influential observations in longitudinal multivariate mixed effects regression models

*Ma, Hua*, Evaluation of diagnostic performance using partial area under the ROC curve

*Olson Hunt, Megan*, A permutation-based correction for Pearson's chi-square test on data with an imputed complex outcome/a modified EM algorithm for contingency table analysis with missing data

*Sampene, Emmanuel*, A simple locally efficient estimator for relative risk in case-cohort studies

*Singhabahu, Dilrukshika*, Robust partial least squares regression and outlier detection using minimum covariance determinant method and a resampling method

*Tang, Shaowu*, Investigations on genomic meta-analysis: Imputation for incomplete data and properties of adaptively weighted Fisher's method

*Zhang, Yang*, Statistical methods for patient chemosensitivity prediction based on in vitro dose-response data and a modified expectation-maximization (EM) algorithm for regression analysis of data with non-ignorable non-response

*Zhou, Xiaozhi*, Sensitivity analysis and uncertainty analysis in a large-scale agent-based simulation model of infectious diseases

DEPARTMENT OF MATHEMATICS SCHOOL OF ARTS AND SCIENCES

*Chuang, Ken-Hsien*, Canonical connections

*Miloua, Attou*, Steady state thin film equation with van der Waals force

*Shim, Hyung Bo*, Indefinite string structure

*Stepien, Tracy*, Collective cell migration in single and dual cell layers

*Tran, Hoang*, Partitioned methods for coupled fluid flow problems

*Tronzo, Mark*, Analysis of a PDE model of necrotizing enterocolitis

*Yu, Cheng*, Some analytical issues for the selected complex fluids models

DEPARTMENT OF STATISTICS

*Li, Siyu*, Simultaneous population and dose selection in clinical trials and cluster validation

*Yavuz, Idil*, Non-parametric inference and regression analysis for cumulative incidence function under two-stage randomization

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## Brown University (26)

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*Austin, Andrea*, Covariate defined latent space models for social networks with extensions to biomolecular pathways

*Chrysanthopoulou, Stavroula*, Statistical methods in micro-simulation modeling: Calibration and predictive accuracy

*Miles, Ott*, Analytic methods for network data

DEPARTMENT OF MATHEMATICS

*Kiral, Eren Mehmet*, Spectral theory and shifted convolution sums in analytic number theory

*Kuan, Chan leong*, Hybrid bounds on twisted $L$-functions associated to modular forms

*Leshin, Jonah*, Class field towers, solvable Galois representations and Noether's problem in Galois theory

*Minevich, Igor*, Cohomology of topological groups and Grothendieck topologies

*Molcho, Samouil*, Log stable maps with torus actions

*Tassy, Martin*, Tiling by bars

*Wheeler, Miles*, Large-amplitude solitary water waves with vorticity and surface pressure

*Wiygul, David*, Doubling constructions with asymmetric sides

DIVISION OF APPLIED MATHEMATICS

*Chen, Zheng*, Recovering exponential accuracy in spectral methods involving piecewise smooth functions with unbounded singularities

*Choi, Minseok*, Time-dependent Karhunen-Loève type decomposition methods for SPDEs

*Freifeld, Oren*, Statistics on manifolds with applications to modeling shape deformations

*Klobusicky, Joe*, Kinetic limits of piecewise deterministic Markov processes and grain boundary coarsening

*McQuighan, Kelly*, Oscillons near Hopf bifurcations of planar reaction-diffusion equations

*Miller, Jeffrey*, Nonparametric and variable-dimension Bayesian mixture models: Analysis, comparison, and new methods

*Parks, Matthew*, Bayesian statistical inference of non-allelic homologous recombination in the human genome using high-throughput sequencing data

*Schuster, Jessica*, A stochastic context free model of epistatic interaction in human genome

*Slivinski, Laura*, Lagrangian data assimilation and its applications to geophysical fluid flows

*Sugden, Lauren*, Structure, variation, and reproducibility: Bayesian inference in problems arising from the study of RNA and RNA-binding protein

*Tirupathi, Seshu*, Discontinuous Galerkin methods for magma dynamics

*Wu, Wei*, Large deviations and quasipotential for finite state mean field interacting particle systems

*Yang, Xiu*, The holy trinity of stochastic modeling and uncertainty quantification: High-dimensionality, sparsity and rare events

*Yu, Yue*, Numerical methods for fluid-structure interaction: Analysis and simulations

*Zhang, Zhongqiang*, Towards high-order methods for stochastic differential equations with white noise: A spectral approach

## University of Rhode Island (4)

DEPARTMENT OF MATHEMATICS

*Phifer, Caitlin*, The cycle intersection matrix and applications to planar graphs and network theory

*Richmond, Daniel*, Implicitly restarted Krylov subspace methods for large-scale least-square problems

*Rudasill, William*, New results and improvements related to the study of multi-specialization whist tournament designs

*Smith, Diana*, Towards Steinberg's conjecture

# SOUTH CAROLINA

## Clemson University (9)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Dandurand, Brian*, Mathematical optimization for engineering design problems

*Galvin, Keith*, Advancements in finite element methods for Newtonian and non-Newtonian flows

*Johnson, Charles*, Involutive translation surfaces and Panov planes

*Livsey, James*, Count time series and discrete renewal processes

*Pandey, Abhishek*, Modeling dengue transmission and vaccination

*Wang, Dewei*, Nonparametric and semiparametric group testing regression models

*Wash, Kirsti*, Identifying codes and domination in graph products

*Weerasena, Lakmali*, Approximations in multiobjective optimization with applications

*Zantout, Dania*, On the cuspidality of Maass-Gristenko and mixed level lifts

## Medical University of South Carolina (4)

DEPARTMENT OF PUBLIC HEALTH SCIENCES

*Chiuzan, Codruta*, Adaptive early-phase designs for assessing toxicity and efficacy outcomes - applications in cancer immunotherapy

*Logan, Sarah*, Psychopharmacotherapy use and adherence in autism spectrum disorders

*Nida, Adrian*, Obtaining sense from senselessness: Using machine learning tools to classify systemic lupus erythematosus from free text regions of an electronic health record

*Wheless, Lee*, The association between common variants in nucleotide excision genes and non-melanoma skin cancer

## University of South Carolina (8)

DEPARTMENT OF MATHEMATICS

*Brown, Kenneth*, Shimura images of a family of half integral weight modular forms

*Dove, Andrew*, Generalizations of Sperner's theorem: Packing posets, families, forbidding posets, and supersaturation

*Harrington, Joshua*, Selected research in covering systems of the integers and the factorization of polynomials

*Johnston, Jeremy*, Turán problems on non-uniform hypergraphs

DEPARTMENT OF STATISTICS

*Chang, Wen*, Bayesian analysis of continuous curve functions

*Hill, Blake*, Permutation testing for covariance matrices, with applications in shape analysis

*Li, Li*, Applications of Bayesian nonparametric to reliability and survival data

*Thompson, Jean Marie*, Methods of clustering mixed data

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## South Dakota State University (4)

DEPARTMENT OF MATHEMATICS AND STATISTICS

*Ban, Yuguang*, Understanding evolution of gene expression by comparative analysis

*Bondalapati, Krishna*, Improving genetic analysis with augmented experimental designs

*Devkota, Mitra*, Spatial data analysis

*Padhy, Budhinath*, Analysis of multivariate longitudinal data using structural equation modeling

# TENNESSEE

## University of Memphis (6)

DEPARTMENT OF MATHEMATICAL SCIENCES

*Chen, Si*, DNA sequence analysis for application to phylogenetic tree construction and simulated metagenomic binning

*Clendenen, Raluca Loana*, Wentzell boundary conditions with general weights and asymptotic parabolicity for strongly damped waves

*Collins, Jared Timothy*, Bad cycles, blowup points and baby Mandelbrot sets

*Hu, Wenrong*, Sample size/power calculation for stratified case-cohort design and generalized stratified case-cohort design

*King, Raena*, Hermitian operators and projections on Hardy spaces

*Winter, Bryan R.*, Design, search and implementation of improved large order multiple recursive generators and matrix congruential generators

## University of Tennessee, Knoxville (6)

DEPARTMENT OF MATHEMATICS

*Fatheddin, Parisa*, Asymptotic behavior of a class of SPDEs

*Lewis, Thomas*, Finite difference and discontinuous Galerkin finite element methods for fully nonlinear second order partial differential equations

*Martinez, Marco V.*, Optimal control for management in gypsy moth models

*Smith, Jesse*, Properties of ideal-based zero-divisor graphs of commutative rings

*White, Joseph*, Isolation and deformation results for commuting squares of finite dimensional star algebras

*Xing, Fei*, Long time asymptotics of Ornstein-Uhlenbeck processes in Poisson random media

## Vanderbilt University (8)

DEPARTMENT OF MATHEMATICS

*Bosuwan, Nattapong*, Two problems in asymptotic analysis: Padé-orthogonal approximation and Riesz polarization constants

*Camp, Wes*, Graph separators and boundaries of right-angled Artin and Coxeter groups

*Marshall, Emily*, Hamiltonicity and structure of classes of minor-free graphs

*Smedberg, Matthew*, Necessary conditions for finite decidability in locally finite varieties admitting strongly Abelian behavior

*Spaeth, Anneliese*, A determination of the existence of various types of positive systems in $L^p$

*Wires, Alexander*, Some resuts in universal algebra

*Wu, Jianchao*, The Novikov conjecture, the group of volume preserving diffeomorphisms and non-positively curved Hilbert manifolds

*Zhou, Dapeng*, The coarse Baum-Connes conjecture and controlled operator $K$-theory

# TEXAS

## Baylor University (10)

DEPARTMENT OF MATHEMATICS

*Eisenbarth, Geoff*, Quadratic Lyapunov theory for dynamic linear switched systems

*Fouts Aceves, Kelly*, On a ring associated to $F[x]$

*Hartsock, Gail*, A combinatorial property of Bernstein-Gelfand-Gelfand resolutions of unitary highest weight modules

*Liu, Xueyan (Sherry)*, Existence and uniqueness of solutions of boundary value problems by matching solutions

*Stewart, Jessica D.*, Spectral analysis of the exceptional Laguerre and Jacobi equations

*Wagner, Bradley*, Finitary incidence algebras

DEPARTMENT OF STATISTICAL SCIENCES

*Beeson, John*, Topics in multivariate covariance estimation and time series analysis

*Carlile, Tom*, Adaptive designs for phase II clinical trials with binary endpoints

*Sides, Ryan*, Sample size determination for two sample binomial and Poisson data models based on Bayesian decision theory

*Yuan, Jiang*, Normal approximation for Bayesian models with non-sampling bias

## Rice University (14)

DEPARTMENT OF COMPUTATIONAL AND APPLIED MATHEMATICS

*Acosta, Sebastian*, Inverse source problems for time-dependent radiative transport

*Du, Bosen*, Adaptive reduction of large spiking neurons

*Hokanson, Jeffrey*, Numerically stable and statistically efficient algorithms for large scale exponential fitting

DEPARTMENT OF MATHEMATICS

*Cooper, James*, Two mod-$p$ Johnson filtrations

*Munger, Paul*, Spectral regularity in some models of aperiodic order

*Ong, Darren*, Spectral characteristics of aperiodic CMV and Schrödinger operators

*Ray, Arumina*, Casson towers and filtrations of the smooth knot concordance group

*Zhang, Letao*, Deformations of Hilbert schemes of points on $K3$ surfaces and representation theory

DEPARTMENT OF STATISTICS

*Affinito, Ricardo*, Identifying and dealing with the approach of bears and their departure

*Egbulefu, Joseph*, Robust GARCH methods and analysis of partial least squares regression

*Jiang, Fei*, Bayesian decision-theoretic method and semi-parametric approach with applications in clinical trial designs and longitudinal studies

*Peterson, Christine*, Bayesian graphical models for biological network inference

*Xu, Yanxun*, Application of Bayesian modeling to high-throughput genomic data and clinical trial design

*Yang, Jingjing*, Smoothing functional data with a Bayesian hierarchical model and robust fitting of a Weibull model with optional censoring

## Southern Methodist University (5)

DEPARTMENT OF MATHEMATICS

*Gardner, David*, Filters for the improvement of multiscale data from atomistic simulations

*Ketelaar, Christiaan*, Stability of electrolyte films on flat and structured substrates

*Pearson, Glen*, The parallel immersed interface method with a triangular mesh representation of an interface

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*Lou, Ying*, Sample size estimation for comparing repeated count measurement using GEE

*Sadler, Bivin*, New methods in item response theory: Information, bias and mean square error

## Texas A&M University (21)

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*Benli, Mustafa*, Presentations and structural properties of self-similar groups and groups without free sub-semigroups

*Bruillard, Paul*, On the classification of low-rank braided fusion categories

*Ghosh, Aditi*, Fast algorithms for biharmonic problems and applications to fluid dynamics

*Hein, Nickolas*, Reality and computation in Schubert calculus

*Moon, Sunghwan*, Properties of some integral transforms arising in tomography

*Nguyen, Hao Thanh*, Greedy strategies for convex minimization

*Qi, Yang*, Geometry of feasible spaces of tensors

*Rusek, Korben*, $\mathscr{A}$-discriminant varieties and amoebae

*Thompson, Travis*, Results towards a sealable multiphase Navier-Stokes solver for high Reynolds number flow

*Tomov, Vladimir*, Entropy viscosity method for Lagrangian hydrodynamics and central schemes for mean field games

*Wang, Kainan*, Parallel Markov chain Monte Carlo methods for large scale statistical inverse problems

*Webster, Jennifer*, Cost-sensitive classification methods for detection of smuggled nuclear material in cargo containers

*Yang, Yuping*, Central limit theorems for empirical processes based on stochastic processes

*Zuo, Lihua*, Inverse problems for fractional diffusion equations

DEPARTMENT OF STATISTICS

*Chen, Hsiang-Chun*, Interference for clustered mixed outcomes from a multivariate generalized linear mixed model

*Cheng, Yichen*, Stochastic approximation and its application in MCMC

*De, Debkumar*, Essays on Bayesian time series and variable selection

*Sun, Ranye*, Thresholding multivariate regression and generalized principal components

*Wei, Rubin*, Highly nonlinear measurement error models in nutritional epidemiology

*Xu, Kun*, Semiparametric estimation and inference with mis-measured, correlated or mixed observations, and the application in ecology, medicine, and neurology

*Zhu, Xinxin*, Wind speed forecasting for power operation

## Texas State University-San Marcos (1)

DEPARTMENT OF MATHEMATICS

*Oktavia, Rini*, Diagnostic assessment to identify students' developmental levels in learning statistics

## Texas Tech University (4)

DEPARTMENT OF MATHEMATICS AND STATISTICS

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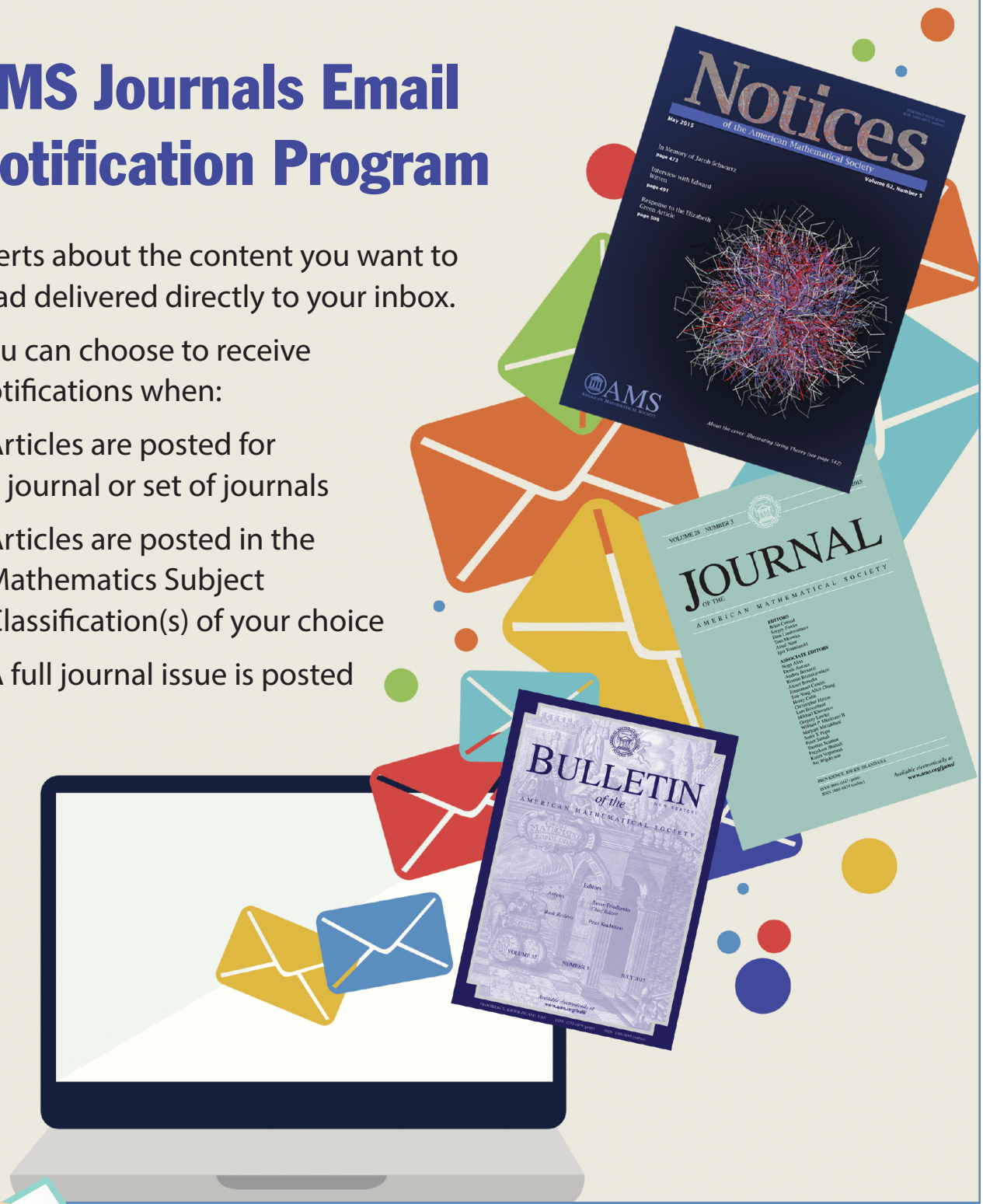


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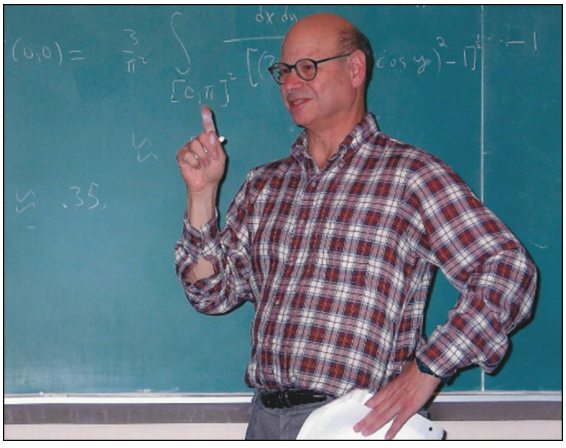
# Albert Baernstein II 1941–2014

*David Drasin*



**Albert Baernstein II**

Albert (Al) Baernstein made significant and original contributions to classical analysis. An outstanding and scrupulous scholar and teacher, he had a special talent for developing his own methods to settle long-standing problems. During his long service at Washington University, he trained a large cadre of PhD students, both from the US and abroad, and their contributions to complex and harmonic analysis continue.

Al's own research impact lies in his approach to symmetrization, now encapsulated by the term *Baernstein star function (Baernstein $\star$-function).* Symmetrization is an ancient concept in mathematical analysis and geometry. Its most famous result is the *isoperimetric principle*: among all plane regions of fixed area, the one of least perimeter is the disk.

The general situation is concerned with a class of functions $\mathfrak{F}$ or domains $\mathfrak{D}$, and the issue is to show that a given functional $\Phi$ is maximized, when restricted to either $\mathfrak{F}$ or $\mathfrak{D}$, by a function $f$ or domain $D$ which has additional regularity or symmetry properties. Al's inspiration from complex analysis arose in unexpected ways; but isoperimetry and symmetry are also important in statistics, probability, physics, potential theory, etc. Pólya-Szegő [MR 0043486] is the classical reference.

Al was raised in Tuscaloosa, Alabama, where his father owned a men's clothing store. Shortly after graduating from Cornell in 1962, he was married to Judy (Haynes) and had lost (nearly all of) his southern accent. A year as a cost analyst in the insurance industry convinced him to switch to graduate school. Thus, in 1963 he and Judy (and their new daughter) moved to Madison, Wisconsin. Al had broad mathematical interests but soon decided to concentrate on analysis, a discipline in which Wisconsin traditionally excelled. He consulted with Simon Hellerstein, whose course in entire and meromorphic functions had fascinated Al. Since Si had a full deck of students, he sent Al to a new colleague, Daniel Shea.

The thesis problem Dan proposed had little to do with symmetrization, but the star function arose from it in a natural manner a few years later. Al was already fascinated by Norbert Wiener's famous Tauberian theorem, so Dan suggested a type of regularity theorem (of Tauberian character) for what at first sight is an artificially narrow class of entire functions (an entire function is a function $f$ analytic in the full complex plane). Functions in this class grow more slowly than the exponential function $w = e^z$ (i.e., $f$ has *order* $\rho < 1$) and, assuming $f(0) = 1$, have the simple factorization

$$f(z) = \prod_n \left(1 - \frac{z}{a_n}\right) \tag{1}$$

(without the assumption of small order, this infinite product will not converge). Their special, defining

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property is that all zeros $\{a_n\}$ lie on the negative real axis.

Since the 1920s the standard method to study entire and meromorphic functions has been with Rolf Nevanlinna's value-distribution theory and characteristic function $T(r), r > 0$; its most famous result is a deep and systematic generalization of E. Picard's theorem, expressed through Nevanlinna's notion of *deficient value*. In the situation here, very little preparation is needed; the *Nevanlinna characteristic* $T(r)$ may be defined as

(2)
$$T(r) = \frac{1}{2\pi} \int_{re^{i\theta} \in P} \log |f(re^{i\theta})|\, d\theta \qquad (0 < r < \infty),$$

where $P = \{z; \log |f(z)| \geq 0\}$. In fact, $T : \mathbb{R}_+ \to \mathbb{R}_+$ is an increasing function whose growth and behavior capture many asymptotic properties of $f$. It is elementary to see from the zeros $\{a_n\}$ in (1) being negative that $P \cap \{|z| = r\}$ is an arc $\{re^{i\theta}, |\theta| \leq \beta(r)\}$ and that $\partial P$ is the arc $\Gamma = \{re^{i\beta(r)}; r > 0\}$ together with its reflection $\overline{\Gamma} = \{re^{-i\beta(r)}; r > 0\}$. The Tauberian nature of the problem is to obtain from an asymptotic formula for $T(r)$ a corresponding asymptotic formula for the number of zeros $\{a_n\}$ inside all large disks $\{|z| < r\}$; the converse relation was known already early in the last century. The location of the curves $\Gamma, \overline{\Gamma}$ is unspecified—only the values of $f$ on them are given—but one consequence of this theorem is that $\Gamma$ and $\overline{\Gamma}$ are asymptotic rays.

By late 1967 Al solved this problem [MR 0257358] with his "nonlinear Tauberian theorem," combining Wiener's theorem with techniques from potential theory and harmonic analysis.

An assistant professorship at Syracuse followed in 1968, where Daniel Waterman was a leading harmonic analyst. In preparation, Al studied a survey article by Waterman and Casper Goffman [MR 0252940] and was able to settle several problems in harmonic analysis stated there [MR 0310523, MR 0304954, MR 0305044]. The genesis of his star function came soon after, from a visit to Syracuse in 1971 by Allen Weitsman. Allen urged Al to work with Albert Edrei (also on the Syracuse faculty and thesis adviser to both Shea and Weitsman) to resolve a problem Edrei had championed for several years: to prove the *spread conjecture*. This refined problem in classical Nevanlinna theory suggested a concrete interpretation of a value $w = a$ being "deficient" in Nevanlinna's sense. Thus let $f$ be meromorphic in the plane of order $\rho$ with deficiency $\delta = \delta(a, f) > 0$ for some $a \in \mathbb{C} \cup \infty$. The conjecture was that there must be a sequence $r_n \to \infty$ and a network of circles $S_n = \{|z| = r_n\}$ so that $|f(r_n e^{i\theta}) - a|$ will be small on a $\theta$-set of angular measure of at least

$$\min\left(\frac{4}{\rho} \sin^{-1} \sqrt{\frac{\delta}{2}}, 2\pi\right)$$

(this sequence $\{r_n\}$ is independent of $a$; a slightly weaker form of this assertion was proposed far earlier by O. Teichmüller).

Within six months Al obtained the spread relation [MR 0372429]. Most significantly, its realization required his creating the star function $T^*(re^{i\theta})$, $(0 \leq \theta \leq \pi)$. The contrast between $T(r)$ (recall (2)) and $T^*$ is evident from the definition

$$T^*(re^{i\theta}) = \max_{|E|=2\theta} \int_E \log |f(re^{i\psi})|\, d\psi,$$

concealing the remarkable property that $T^*$ is subharmonic in the upper half-plane $H : \{re^{i\theta}, 0 < \theta < \pi\}$. When applied to a general entire function $f$ (not of the form (1)), $T^*$ converts the values $\{f(re^{i\theta}), |\theta| \leq \pi\}$ into their *symmetric decreasing rearrangement*, a procedure standard in symmetrization, and then integrates back. The spread relation then followed from analysis of the subharmonic function $T^*$ with known boundary values on $\partial H$. (The definitions of $T$ and $T^*$ are slightly more complicated when $f$ has poles.)

While Al and many authors later applied the star function to other questions about meromorphic functions, several classical problems in which these functions grow more rapidly than the exponential function (i.e., functions of order $\rho > 1$) seem to require different methods and remain open.

Al's proof of the spread relation led to prompt international recognition and an offer in 1971 from Washington University in St. Louis. Since this breakthrough occurred early in his career, he, along with his students, coauthors and the full mathematical world, had many opportunities, which led to an invitation to address the 1978 International Congress in Helsinki [MR 562666], but made him a frequent and popular speaker at many mathematical conferences and symposia. The results of many of these presentations remain in the literature as surveys of and orientations on a wide variety of topics.

Walter Hayman recalls the contemporary impact of $T^*$: "I remember well when I first met Al

Baernstein at the conference in Canterbury in 1973. He told us about his invention of the star function and how you could use it to prove Edrei's spread conjecture and to solve a number of other problems. So he became the star of the conference. He has been one of the brightest stars in the sky of function theory ever since."

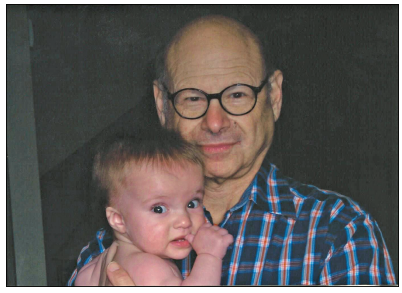
For the rest of his life, the center of Al's activities was at Washington University, where he and Judy raised their daughters, Prudence Renée and Amy, and hosted legions of visitors and students. The Baernsteins loved the spirit of the mathematics department and especially the cultural life in St. Louis, with its rich traditions in music and opera. Al's passion for the drama of the libretti matched his love of the music, and he and Judy were proud supporters of St. Louis opera companies. Indeed, his memory for libretti as well as for dates, events, talks, and on their many mathematical memories seemed almost beyond human capacity.

The Baernsteins thrived on outdoor activities, from matters as routine as Al's daily walks to his office to family float trips on Missouri rivers and long hikes both near home and during their many trips. Judy hailed from Maine, and nearly annual summer pilgrimages to their cabin in Maine and hikes in Acadia National Park were cherished family rituals. Al had serious cardiac issues all his life, but superb medical care allowed him to remain active until his last years, when a neurological disease made both mathematics and intense physical activity impossible.

Shortly after arriving in St. Louis, Al propelled his theory far beyond meromorphic functions in his most-cited paper (*Acta Mathematica* [MR 0417406]). One famous result dealt with univalent (one-one) functions $S : f(z) = z + \sum_{j\geq 2} a_j z^j$ in the unit disk $D := \{|z| < 1\}$. The presumed extremal function $k(z) = z/(1-z)^2 = \sum_{j\geq 1} jz^j$ (Koebe function) maps $D$ onto the plane with the radial segment $(-\infty, -1/4]$ deleted, so that $k(D)$ has maximal symmetry. Bieberbach's famous conjecture was that if $f \in S$, $f \neq k$, then $|a_j| < j$ for every $j \geq 2$ (finally proved in 1985 by de Branges). That $k$ is extremal in other respects is also evident from Al's main result, which stands independently of de Branges's: *If $\Phi$ is convex on $(-\infty, \infty)$ and $r > 0$, then the integral means $\int_{-\pi}^{\pi} \Phi(\pm \log |f(re^{i\theta})|)\, d\theta$ are extremal when $f(z) = k(z)$* (if $\Phi$ is strictly convex, $k$ is the unique extremal). The paper contains many other applications, for example, that symmetrization increases the $L_p$-means of Green's functions. Good accounts now appear in standard monographs, e.g., Duren [MR 0708494] and volume 2 of Hayman [MR 1049148]. Relatively recently, Al published a major main chapter in Kühnau's encyclopedia [MR 1966196], with his own survey of the star function's impact in complex analysis. Some years earlier, he began to prepare his own research monograph, *Symmetrization in Analysis,* one purpose being to present a full account of the star function in the universe of rearrangements, harmonic analysis, and geometric measure theory. Although about 20 percent of the project remained incomplete at his death, enough instructions and outlines were left to enable a group of colleagues and former students to prepare a full version for publication.

**Bar Harbor, Maine. June 14, 1962.**

When Al arrived, Washington was already a powerhouse in classical mathematical analysis, primarily related to the Zygmund school of harmonic analysis. Al flourished in this environment while developing his own research agenda. A strong cadre of graduate students interested in analysis was arriving (notably from Spain and Italy) by the 1970s, and several soon chose Al as research mentor. He took mentoring very seriously, and subjects pursued by students ranged far beyond his own research. His fifteen PhD students (having at present nearly over twice as many additional descendants) provide clear evidence of his success. In this way he also partially fulfilled some vicarious dreams, such as being a probabilist. Students and colleagues fondly recall his warmth, care, and special mannerisms (waving hands, telling jokes, teaching in bare feet, making amusing faces). But Al also carefully adapted his style to each student.



One comment from Carlo Morpurgo reflects a significant aspect of Al's immense value to his graduate students. "After a little while, [Al] laid out Plan A, which involved a sexy-sounding problem in spectral geometry. The problem was easy to state and with enough evidence to make one think that it was within reasonable reach. Alas, it turned out to be very hard, and to this day it is still unsolved.…Al soon realized that I am not a guy that easily gives up, and he let me continue with that journey, supporting the small progress that I was making and offering a helping hand when I needed one. In 1992 I did not have enough for a thesis, and I was stuck on a difficult inequality. Al told me that he had a safer Plan B for me, but he still let me continue, until I was eventually able to prove the inequality and obtain satisfactory partial results toward the original problem. I regret not having thanked Al enough for giving me a hard PhD problem and for supporting my stubbornness,

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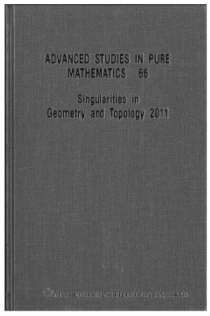


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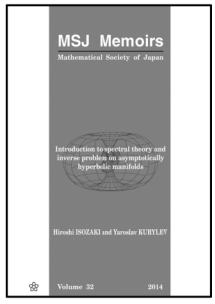


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allowing me to go on with Plan A almost to the point of no return."


### Acknowledgments

Comments and insights from Judy Baernstein, Juan Manfredi, and Rick Laugesen were important ingredients to the final text. In addition, Alex Eremenko, Luigi Fontana, James Gill, Cristobál González, Walter Hayman, Carlo Morpurgo, Dan Shea, Misha Sodin, and Allen Weitsman provided helpful suggestions and recollections.

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# On Leibniz, Expanded Edition

*Eberhard Knobloch*

**On Leibniz, Expanded Edition**
*Nicholas Rescher*
*University of Pittsburgh Press, June 2013*
*416 pages, US$28.95*
*ISBN-13: 978-0-822-96218-2*

Nicholas Rescher (born 1928), a leading American philosopher, has much to say about Leibniz. Hence, in principle such a collection of twenty-one articles dealing with Leibniz's life and thought is praiseworthy. This paperback edition is an expanded version of the original.

Unfortunately, the book disappoints in several ways. For example, its structure is not quite clear. In his short preface (p. ix) Rescher speaks of eleven chapters into which the articles have been thematically organized; the reader will look in vain for such chapters. The articles are simply numbered all the way through, from one to twenty-one. Hence, there is no closing chapter 11 that "offers a case study of how current issues can be addressed on Leibnizian principles". In reality the last two papers deal with the question of whether Leibniz was ennobled (he was not!) and his difficult relationship with Johann Daniel Crafft.

According to Rescher's remark (p. ix) the articles are reprinted unrevised as originally published. However, on page 105 he explains that the fourth essay on Leibniz and the plurality of space-time frameworks is a "somewhat revised version of a paper of the same title that appeared" in 1977. Unfortunately in only eleven cases does he mention the references to the original publications from 1977 through to 2006 (papers 1, 2, 3, 4, 5, 6, 10, 12, 13, 14). Sometimes the reader gets this information from Rescher's homepage: `www.pitt.edu/~rescher`. There it is mentioned that paper 7 appeared in 2011 and paper 19 in 2003.

Worse than this editorial carelessness is the fact that the unrevised reprinted papers are riddled with mistakes. When Greek, Latin, German, or French words appear, the text is frequently distorted by incorrect spelling. For example, one finds substituti for substitui (p. 4, line -4), principle for principe (p. 46, line -11), possibilatis for possibilitatis (p. 67, note 34), cilui for celui (p. 108, line -4), Veterorum for Veterum (p. 131, note 12), and, in many places, Die philosophische Schriften for Die philosophischen Schriften.

All other mistakes have been reprinted, too. For example, "the North American G. W. Leibniz Society was allegedly launched in 1900" (p. 298, line 9); "the meaning of apokalypsis is not destruction but revelation" (p. 177).

Such a reprint is indeed annoying, while a revised, corrected reprint would have been welcome, for Rescher's articles remain interesting and valuable contributions to the research on Leibniz. He is right in believing (p. ix) "that the points they make remain substantially tenable and intact in the face of subsequent investigations". We cite the following articles from the book as an indication of the range of Rescher's contributions. In his papers *Leibniz on possible worlds*, *Contingentia mundi*, and *Leibniz and the concept of a system*, Rescher rightly emphasizes that Leibniz drew his inspiration from mathematics, that Leibniz the philosopher was indebted to Leibniz the mathematician. The two papers *Leibniz on intermonadic relations* and *Leibniz and the plurality of space-time frameworks*

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DOI: http://dx.doi.org/10.1090/noti1267

refer to some principles Leibniz held, such as the notion that "everything is interconnected" and the principle of identity of indiscernibles. The papers *Leibniz and issues of eternal recurrence*, *Leibnizian Neo-platonism and rational mechanics*, and *Leibniz and the world's improvability* discuss the influence of ancient philosophers on Leibniz's thinking. *The epistemology of inductive reasoning in Leibniz* tries to demonstrate that Leibniz was an empiricist. Other papers discuss Leibniz's interest in law, probability theory, combinatorics, and cryptography; his projects for the improvement of medical practice; and certain periods of Leibniz's life (the Parisian period, his visit to Vienna, etc.).

Especially interesting for Europeans are the two papers that describe the American Leibnizian scholarship and Leibniz's influence on American philosophy. The Austrian Kurt Gödel is dealt with as an American thinker.

This volume is a valuable resource on the life and thinking of Leibniz. And yet, this reviewer cannot avoid the conclusion that an opportunity has been missed. Had more attention been paid to the overall presentation and to correcting errors, the book could have been a truly outstanding contribution.


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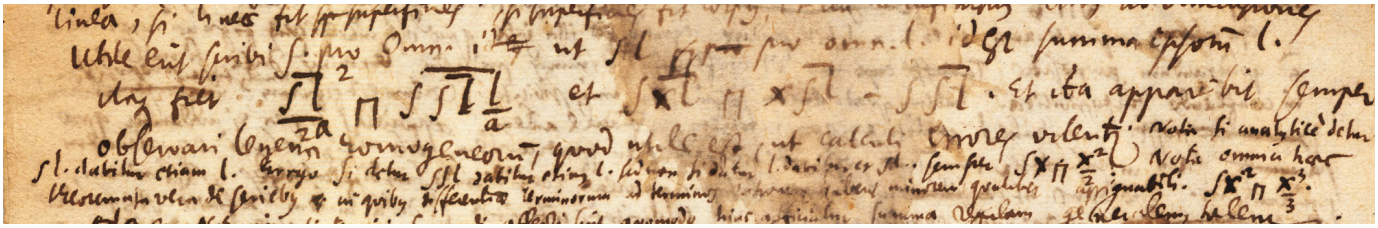

# Leibniz Inventing the Calculus

This issue contains a review by Eberhard Knobloch of a collection of articles about Leibniz. The articles under review are mostly concerned with Leibniz's philosophical writings, but of course to us he is best known for his mathematics, primarily his role in the invention of differential and integral calculus. Indeed, the term "calculus," signifying an algorithm, is his own.

The manuscript page on the cover shows the moment that Leibniz introduced the integral sign $\int$. It is from one of several memoranda he wrote to himself during his remarkable stay in Paris during the years 1672–1676. These were discovered in Hannover and transcribed by Carl Immanuel Gerhardt in the mid-nineteenth century. The particular one at hand is dated October 29, 1675.

Leibniz's scribblings are certainly hard to read, and at some point the manuscript seems to have suffered water damage. In Gerhardt's transcription (with a minor correction): *Utile erit scribi* $\int$ *pro omn., ut* $\int \ell$ *pro omn.* $\ell$*, id est summa ipsorum* $\ell$*. Itaque fiet* $\frac{\overline{\int \ell}^{1}}{2a} \sqcap \int \overline{\int \ell}\, \frac{\ell}{a}$ *et* $\int \overline{x\ell} \sqcap x\overline{\int \ell} - \overline{\int \int \ell}$*. Et ita apparebit semper observari legem homogeneorum, quod utile est ut calculi errores vitentur. Nota: si analytice detur* $\int \ell$*, dabitur etiam* $\ell$*. Ergo si detur* $\int \int \ell$*, dabitur etiam* $\ell$*, sed non si datur* $\ell$*, dabitur et* $\int \ell$*. Semper* $\int x \sqcap \frac{x^2}{2}$.

In the English of J. M. Child, this starts out
*It will be useful to write* $\int$ *for omn., so that*

$$\int \ell \sqcap \operatorname{omn} \ell, \text{ or the sum of the } \ell\text{'s.}$$

Here omn is an abbreviation of *omnia*, which for Leibniz means an infinite sum of all of something. He writes $\sqcap$ for $=$. Instead of parentheses he writes lines over expressions. He hasn't got around yet to writing $\int \ldots dx$, or to using functional notation. These all come later. He uses a kind of "dummy" variable $a$ because he says that homogeneous expressions make errors easier to spot. Curiously, one of these $a$'s is missed in Gerhardt's transcription, and subsequent authors continue this error because the manuscript is not available to them.

Leibniz then goes on to say that

$$\frac{(\int \ell)^2}{2} \sqcap \int \left( \int \ell \right),$$

or in our only slightly different terminology

$$\frac{x^2}{2} \sqcap \int x\, dx.$$

He also exhibits a version of what we know as integration by parts that eventually gives him:

$$\int x^2\, dx \sqcap \frac{x^3}{3}.$$

References for this material include:


• Carl Immanuel Gerhardt, **Der Briefwechsel von Gottfried Wilhelm Leibniz mit Mathematikern**, Berlin, 1899.

This is a transcription of Leibniz's original Latin. The passage we are concerned with is to be found on p. 154. As you can see from the image above, Gerhardt's task cannot have been easy. It ought not to be very surprising that an $a$ was left out of one denominator.

• J. M. Child, **The Early Mathematical Manuscripts of Leibniz**, Open Court, 1920.

The passage at hand is on p. 80.

• André Weil, "A review of 'Leibniz in Paris 1672–1676' by Joseph Hofmann," *Bulletin of the AMS*, 1975.

This an extremely enjoyable account.

• C. H. Edwards Jr., **The Historical Development of the Calculus**, Springer, 1979.

Pages 252–254 are about this memorandum.


The first three of these can be found on the Internet for free download.


We wish to thank Eberhard Knobloch for advice, and the Gottfried Wilhelm Leibniz Bibliothek for making the cover image available to us.



*—Bill Casselman*
*Graphics Editor*
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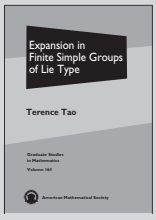


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**Terence Tao**, *University of California, Los Angeles, CA*

This text focuses on Cayley graphs on finite groups of Lie type, developing tools such as quasirandomness and product estimates.

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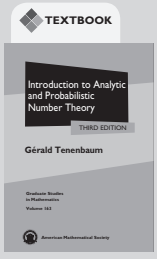


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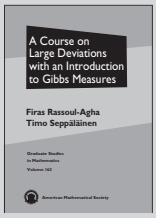


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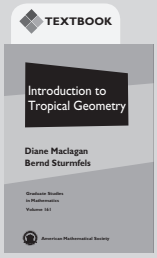


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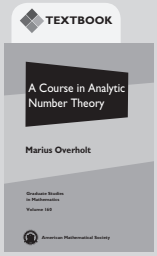


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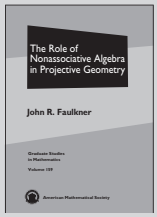


## The Role of Nonassociative Algebra in Projective Geometry

**John R. Faulkner**, *University of Virginia, Charlottesville, VA*

[The book provides] a largely self-contained, in-depth account of the linkage between nonassociative algebra and projective planes.

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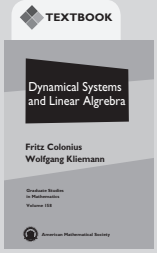


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**Fritz Colonius**, *Universität Augsburg, Germany*, and **Wolfgang Kliemann**, *Iowa State University, Ames, IA*

[This book provides] an introduction to the interplay between linear algebra and dynamical systems in continuous time and in discrete time.

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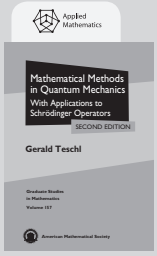


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# Mathematics People

## Bayer and Coates Awarded Adams Prize

AREND BAYER of the University of Edinburgh and THOMAS COATES of Imperial College London have been jointly awarded the 2015 Adams Prize, given this year in the field of algebraic geometry.

According to Raymond Goldstein, chairman of the Adams Prize Adjudicators, "Arend Bayer has made outstanding contributions to spaces of stability conditions on derived categories. His work has novel applications in key areas of modern algebraic geometry, including spaces of Bridgeland stability conditions on derived categories of Calabi-Yau threefolds, wall-crossing and the minimal model program in the birational geometry of moduli spaces. Tom Coates's work answers many fundamental questions in Gromov-Witten theory, quantum cohomology, mirror symmetry, and birational geometry. These include the quantum Lefschetz hyperplane section theorem, the Crepant resolution and wall-crossing conjectures, and the modularity of the generating function for Gromov-Witten invariants of Calabi-Yau threefolds."

The Adams Prize is awarded each year jointly by the Faculty of Mathematics at the University of Cambridge and St. John's College to a young researcher or researchers based in the United Kingdom doing first-class international research in the mathematical sciences. The prize is named after the mathematician John Couch Adams and was endowed by members of St. John's College. It is currently worth approximately £15,000 (approximately US$23,000), of which one-third is awarded to the prizewinner on announcement of the prize, one-third is provided to the prizewinner's institution (for research expenses of the prizewinner), and one-third is awarded to the prizewinner on acceptance for publication in an internationally recognized journal of a substantial (normally at least twenty-five printed pages) original survey article of which the prizewinner is an author.

*—From a University of Cambridge announcement*

## Kritzer Awarded 2015 IBC Prize

PETER KRITZER of the University of Linz, Austria, has been named the recipient of the 2015 Information-Based Complexity (IBC) Prize. The prize consists of US$3,000 and a plaque to be presented at the Seminar on Algorithms and Complexity for Continuous Problems, Schloss Dagstuhl, Germany, September 2015. This annual prize is given for outstanding contributions to information-based complexity.

*—Joseph F. Traub, Columbia University*

## Prizes of the Math Society of Japan

The Mathematical Society of Japan (MSJ) has awarded several prizes for 2015.

The Spring Prize has been awarded to KENICHI KAWARABAYASHI of the National Institute for Informatics for his outstanding contributions to the study of graph minor theory and its application to computational complexity theory. The Spring Prize is awarded to those under the age of forty who have obtained outstanding mathematical results.

The Algebra Prize has been awarded to SYU KATO of Kyoto University for his geometric studies on quantum groups and Hecke algebras.

The Outstanding Paper Prize is awarded each year to the authors of the most outstanding articles published in the *Journal of the Mathematical Society of Japan* (JMSJ) during the preceding year. For 2015 the awardees were: JOACHIM HILGERT, Universität Paderborn; TOSHIYUKI KOBAYASHI, University of Tokyo; and JAN MÖLLERS, Aarhus University, for their joint paper "Minimal representations via Bessel operators," *Journal of the Mathematical Society of Japan* **66** (2014), no. 2, 349–414; to NGUYEN TIEN ZUNG and NGUYEN VAN MINH, Institut de Mathématiques de Toulouse, for their joint paper "Geometry of nondegenerate $\mathbf{R}^n$-actions on $n$-manifolds," *Journal of the Mathematical Society of Japan* **66** (2014), no. 3, 839–894; and to HIDE-

HIKO MISHOU, Tokyo Denki University, for the paper "Functions," *Journal of the Mathematical Society of Japan* **66** (2014), no. 4, 1105–1126.

The JSPS Prize of the Japan Society for the Promotion of Science (JSPS) was awarded to TSUYOSHI TAKAGI of Kyushu University of Informatics and YUKINOBU TODA of the University of Tokyo. Takagi was recognized for his contributions to security analysis and efficient implementation of public-key cryptography. Toda was recognized for his contributions to derived category of coherent sheaves and counting invariants.

The Inoue Prize for Science was awarded to MASAKI IZUMI of Kyoto University for his contributions to the theory of operator algebras.

*—From MSJ announcements*

# Kleinberg Receives Newell Award

JON KLEINBERG of Cornell University has been awarded the 2014 Allen Newell Award of the Association for Computing Machinery (ACM) and the Association for the Advancement of Artificial Intelligence (AAAI) "for groundbreaking work in computer science on social and information networks, information retrieval, and data science, and for bridging computing, economics, and the social sciences." According to the prize citation, Kleinberg "contributed to the development of link analysis, a search technique that ranks the absolute number as well as the most relevant, trusted sources of pages linked to a Web search query. His innovative models and algorithms have broadened the scope of computer science to extend its influence to the burgeoning world of the Web and the social connections it enables." The prize carries a cash award of US$10,000.

*—From an ACM announcement*

# AWM Essay Contest Winners Announced

The Association for Women in Mathematics (AWM) has announced the winners of its 2015 essay contest, "Biographies of Contemporary Women in Mathematics." The grand prize was awarded to MAKAYLA GATES, Valencia Middle School, Peralta, New Mexico, for her essay "Oasis in the Desert," about Mrs. Gretta Aguilar of Valencia Middle School. The essay also won first place in the middle school category and will be published in the *AWM Newsletter*. First place in the undergraduate category was awarded to RAMITA KONDEPUDI, Harvey Mudd College, for her essay "Painting with the President: Maria Klawe—Mathematician, Artist, and Educator." First place in the high school category was awarded to KINA SEKITO, Troy High School, Troy, Ohio, for her essay "If the Parameters Change," about Dr. Irina Kogan of North Carolina State University.

*—From an AWM announcement*

# USA Mathematical Olympiad

The 2015 USA Mathematical Olympiad (USAMO) was held April 28–29, 2015. The students who participated in the Olympiad were selected on the basis of their performances on the American High School and American Invitational Mathematics Examinations. The twelve highest scorers in this year's AMO, listed in alphabetical order, were: RYAN ALWEISS, Bergen County Academies, Hackensack, New Jersey; KRITKORN KARNTIKOON, Loomis Chaffee School, Windsor, Connecticut; MICHAEL KURAL, Greenwich High School, Greenwich, Connecticut; CELINE LIANG, Saratoga High School, Saratoga, California; ALLEN LIU, Penfield Senior High School, Penfield, New York; YANG LIU, Ladue Horton Watkins High School, St. Louis, Missouri; SHYAM NARAYANAN, Blue Valley West High School, Overland Park, Kansas; KEVIN REN, Torrey Pines High School, San Diego, California; ZHUOQUN SONG, Phillips Exeter Academy, Exeter, New Hampshire; DAVID STONER, South Aiken High School, Aiken, South Carolina; KEVIN SUN, Phillips Exeter Academy, Exeter, New Hampshire; and DANIELLE WANG, Stanford Math Circle/Stanford University, Stanford, California.

The twelve USAMO winners will attend the Mathematical Olympiad Summer Program (MOSP) at the University of Nebraska, Lincoln, in June 2015. Ten of the twelve will take the team selection test to qualify for the US team. The six students with the highest combined scores from the test and the USAMO will become members of the US team and will compete in the International Mathematical Olympiad (IMO) to be held in Thailand in July 2015.

*—From Mathematical Association of America announcements*

# Moody's Mega Math Challenge

The winners of the 2015 Mega Math Challenge for high school students have been announced. The topic for this year focused on the question, "STEM Sells: What Is Higher Education Really Worth?"

A team from the North Carolina School of Science and Mathematics in Durham, North Carolina, was awarded the Summa Cum Laude team prize of US$20,000 in scholarship money. The students were MICHAEL AN, GUY BLANC, EVAN LIANG, SANDEEP SILWAL, and JENNY WANG. Their coach was Daniel Teague.

The Magna Cum Laude Team Prize of US$15,000 in scholarship money was also awarded to a team from North Carolina School of Science and Mathematics. The students were VINAY KSHIRSAGAR, ALEX LI, HOWARD LI, GRAHAM PASH, and KESHAV PATEL, and they were also coached by Daniel Teague.

The Cum Laude Team Prize of US$10,000 in scholarship money was awarded to a team from Elk River High School, Elk River, Minnesota. The students were JORDAN HAACK, PETER JONES, CHASE GAUTHIER, JOE EVANS, and ZACH GLASGOW. Their coach was Curt Michener.

The Meritorious Team Prize of US$7,500 in scholarship money was awarded to a team from Staples High School, Westport, Connecticut. The team members were

CHAIHYUN KIM, CLAUDIA LANDOWNE, CLAIRE SAMPSON, TERRIE YANG, and MADELINE SCHEMEL, and their coach was Kerrigan Warnock.

The Exemplary Team Prize of US$5,000 was awarded to a team from Maggie Walker Governor's School, Richmond, Virginia. The team members were WILL OVERMAN, WILTON WU, ALAN ZHANG, PRANAY VISSA, and ANANT KHARKAR. They were coached by Dickson Benesh.

The First Honorable Mention Team Prize of US$2,500 was awarded to a team from South County High School, Lorton, Virginia. The team members were BRIAN KING, TRUNG NGUYEN, ALEX COPPEANS, PETER WANG, and JAMES WANG. Their coach was Daniel Southard.

The Mega Math Challenge invites teams of high school juniors and seniors to solve an open-ended, realistic, challenging modeling problem focused on real-world issues. The top five teams receive awards ranging from US$5,000 to US$20,000 in scholarship money. The competition is sponsored by the Moody's Foundation, a charitable foundation established by Moody's Corporation, and organized by the Society for Industrial and Applied Mathematics (SIAM).

*—From a Moody's Foundation/SIAM announcement*

# NCTM Lifetime Achievement Awards

The National Council of Teachers of Mathematics (NCTM) has chosen three educators to receive Lifetime Achievement Awards for 2015. They are M. KATHLEEN HEID of Pennsylvania State University, FRANKLIN DEMANA of Ohio State University, and BERT K. WAITS, also of Ohio State University.

According to the prize citations, Heid "has tirelessly worked to improve mathematics education through her research, teaching, and service at the local, state, and national levels. She has been a trailblazer in using technology to support students' mathematics learning, beginning with her early work with graphing technologies to her more recent work with computer algebra systems. Heid's research on a functional approach to the teaching of algebra broke new ground and has significantly altered the way in which algebra is taught today." Demana, "working jointly with Bert Waits, had a profound effect on mathematics instruction on both a national and an international level. He developed specifications for graphic applications, first for personal computers, and then for handheld graphing calculators. In fact, his ideas inspired the introduction of special capabilities of the calculators themselves." Waits was cofounder of T3, Teachers Teaching with Technology, along with Demana. He was the cofounder and director of the Ohio Early College Mathematics Placement Testing Program of the Ohio Board of Regents.

*—From an NCTM announcement*

# National Academy of Sciences Elections

The National Academy of Sciences (NAS) has elected eighty-four new members and twenty-one foreign associates for 2015. Following are the new members whose work involves the mathematical sciences: ALEXANDER ESKIN, University of Chicago; DONALD GEMAN, Johns Hopkins University; TOMASZ MROWKA, Massachusetts Institute of Technology; RICHARD TAYLOR, Institute for Advanced Study; and MOSHE VARDI, Rice University. Elected as foreign associates were MANINDRA AGRAWAL, Indian Institute of Technology; MAXIM KONTSEVICH, Institut des Hautes Études Scientifiques; and KURT MEHLHORN, Max Planck Institute for Informatics.

*—From an NAS announcement*

# AAAS Elections

The American Academy of Arts and Sciences (AAAS) has elected 197 new fellows and 16 foreign honorary members for 2015. Following are the names and institutions of the new fellows in mathematics, applied mathematics and statistics: LÁSZLÓ BABAI, University of Chicago; GÉRARD BEN AROUS, New York University; BJÖRN ENGQUIST, University of Texas at Austin; IGOR B. FRENKEL, Yale University; WILLIAM P. MINICOZZI II, Massachusetts Institute of Technology; JILL PIPHER, Brown University; and ROGER M. TEMAM, Indiana University. DAVID R. MORRISON, University of California Santa Barbara, was elected in the category of Intersection Candidates. Also honored are three researchers in computer science whose work involves considerable mathematics: SANJEEV ARORA, Princeton University; JOSEPH Y. HALPERN, Cornell University; and RAVINDRAN KANNAN, Microsoft Research Labs, Bangalore, India.

*—From an AAAS announcement*

# Joseph Lehner, 1912–2013

Joseph Lehner was born in New York City on October 29, 1912, to Louis and Rachel (Rosenblum) Lehner and died in Haverford, Pennsylvania, on August 5, 2013. Lehner's scientific work was primarily concerned with automorphic forms for discontinuous groups and related number theory. He also was well known for his earlier research on diffusion cascades and neutron transport for the Manhattan Project and at the Los Alamos Laboratories.

In 1964, Lehner published one of the first treatises in English on automorphic forms [2], which included both the historical beginnings of the subject, as well as later developments, due especially to E. Hecke, H. Petersson, H. Rademacher, and C. L. Siegel. This book has become a classic and has served as an introductory book to automorphic forms for many generations.

Lehner's seminal joint paper with Oliver Atkin [1] introduced a method to study the arithmetic of modular

forms which fundamentally changed the field. The idea was to collect together forms for congruence subgroups $\Gamma_0(m)$ for all $m \geq 1$. For forms of $\Gamma_0(m)$, they distinguished "oldforms," which arise naturally from cusp forms of $\Gamma_0(n)$ with $n$ dividing $m$, and "newforms," which are forms that genuinely live in $\Gamma_0(m)$. They pioneered the "theory of newforms," which reduces the study of the arithmetic of modular forms for $\Gamma_0(m)$ to that of newforms, and they studied the arithmetic of newforms in detail. The Atkin-Lehner theory of newforms was extended by T. Miyake [4] to forms for congruence subgroups $\Gamma_1(n)$ and completed by Li [3] for forms for all congruence subgroups of $SL_2\mathbf{Z}$. The newform theory naturally led to automorphic forms and automorphic representations for $GL_2$ in the adelic setting, and it therefore has had a far-reaching impact in the theory of automorphic forms. To date, researchers have been extending their ideas to study newforms for orthogonal groups. The Atkin-Lehner operators introduced in their paper [1] also play a fundamental role in the study of elliptic and Shimura modular forms.

Lehner earned his BS at New York University (1938) and his MA (1939) and PhD (1941) at the University of Pennsylvania under the supervision of Hans Rademacher. He began his academic career as an instructor at Cornell in 1941 but left in 1943 to join Kellex Corporation. Three years later, he became head of the mathematics group at Hydrocarbon Research Inc. Lehner returned briefly to academia as an associate professor at the University of Pennsylvania from 1949 to 1952 before joining Los Alamos Scientific Laboratory for five years. In 1957 he returned to academic pursuits to become professor at Michigan State University for six years, followed by nine years at the University of Maryland. His last position was as Mellon Professor at the University of Pittsburgh from 1972 to 1980.

Lehner published two books and sixty-seven research papers, with five arising from his work in defense. He had eleven coauthors, with Marvin Knopp and Morris Newman being his most frequent collaborators.

Lehner's education was delayed by the Great Depression. He worked for Macy's for seven years and for the WPA before beginning college courses at the University of Pennsylvania, where he met his future wife, Mary Beluch. They had one daughter, Zheindl, née Janet to whom we are grateful for providing much of the information in this remembrance.

**References**

[1] A. O. L. Atkin and J. Lehner, Hecke operators on $\Gamma_0(m)$, *Math. Ann.* **185** (1970), 134–160.

[2] J. Lehner, *Discontinuous Groups and Automorphic Functions*, Mathematical Surveys, No. VIII, American Mathematical Society, Providence, RI, 1964.

[3] W.-C. W. Li, Newforms and functional equations, *Math. Ann.* **212** (1975), 285–315.

[4] T. Miyake, On automorphic forms on $GL_2$ and Hecke operators, *Ann. Math.* **94** (1971), 174–189.

*—Bruce C. Berndt, Wen-Ching Winnie Li, and J. R. Smart*

**In Memoriam**

**John Forbes Nash**

**1928–2015**

**Distinguished Mathematician, Abel Prize Laureate, Author, and Friend**

# Mathematics Opportunities

## AMS Scholarships for "Math in Moscow"

The Math in Moscow program at the Independent University of Moscow (IUM) was created in 2001 to provide foreign students (primarily from the US, Canada, and Europe) with a semester-long, mathematically intensive program of study in the Russian tradition of teaching mathematics, the main feature of which has always been the development of a creative approach to studying mathematics from the outset—the emphasis being on problem solving rather than memorizing theorems.

Indeed, discovering mathematics under the guidance of an experienced teacher is the central principle of the IUM, and the Math in Moscow program emphasizes in-depth understanding of carefully selected material rather than broad surveys of large quantities of material. Even in the treatment of the most traditional subjects, students are helped to explore significant connections with contemporary research topics. The IUM is a small, elite institution of higher learning focusing primarily on mathematics and was founded in 1991 at the initiative of a group of well-known Russian research mathematicians, who now compose the Academic Council of the university. Today, the IUM is one of the leading mathematical centers in Russia. Most of the Math in Moscow program's teachers are internationally recognized research mathematicians, and all of them have considerable teaching experience in English, typically in the United States or Canada. All instruction is in English.

Pending renewal of funding from the National Science Foundation (NSF), the AMS intends to award five scholarships in the amount of US$9,800 for the spring 2016 semester and five scholarships in the amount of US$10,200 for the fall 2016 semester to US students to attend the Math in Moscow program. To be eligible for the scholarships, students must be either US citizens or enrolled at a US institution at the time they attend the Math in Moscow program. Students must apply separately to the IUM's Math in Moscow program and to the AMS Math in Moscow Scholarship program. Undergraduate or graduate mathematics or computer science majors may apply. The deadlines for applications for the scholarship program are **September 15, 2015** for the spring 2016 semester and **April 15, 2016** for the fall 2016 semester. Information and application forms for Math in Moscow are available on the Web at `www.mccme.ru/mathinmoscow` or by writing to: 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 `www.ams.org/programs/travel-grants/mimoscow` or by writing to: Math in Moscow Program, Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294; email `student-serv@ams.org`.

*—AMS Membership and Programs Department*

## Call for Nominations for Abel Prize

The Norwegian Academy of Science and Letters awards the Abel Prize each year to recognize outstanding scientific work in the field of mathematics, including mathematical aspects of computer science, mathematical physics, probability, numerical analysis and scientific computing, statistics, and also applications of mathematics in the sciences. The prize carries a cash award of 6 million NOK (approximately US$786,000). The deadline for nominations is **September 15, 2015**. For more information see `www.abelprize.no/c53676/artikkel/vis.html?tid=53705`.

*—From a Norwegian Academy announcement*

# Applications for Adams Prize 2015–2016

Applications are being accepted for the 2015–2016 Adams Prize, which will be awarded for achievements in the field of applied analysis. The prize is open to any person under the age of forty who will hold an appointment in the United Kingdom either in a university or in some other institution as of October 31, 2015. (In exceptional circumstances the age limit may be relaxed.) The value of the prize is expected to be approximately £15,000 (approximately US$23,000), of which one-third is awarded to the prizewinner on announcement of the prize, one-third is provided to the prizewinner's institution (for research expenses of the prizewinner), and one-third is awarded to the prizewinner on acceptance for publication in an internationally recognized journal of a substantial (normally at least twenty-five printed pages) original article of which the prizewinner is an author, surveying a significant part of the winner's field.

The deadline for receipt of applications is **October 31, 2015**. For more information see the website `www.maths.cam.ac.uk/news/4.html`.

*—From a University of Cambridge announcement*

# Call for Nominations for 2016 Sunyer Prize

The Ferran Sunyer i Balaguer Foundation seeks nominations for the 2016 Ferran Sunyer i Balaguer Prize. The prize is awarded for a mathematical monograph of an expository nature presenting the latest developments in an active area of research in mathematics. The prize consists of 15,000 euros (approximately US$16,700), and the winning monograph will be published in Birkhäuser Verlag's series Progress in Mathematics. The deadline for nominations is **December 3, 2015**. For more information see the website `ffsb.iec.cat`.

*—Fundació Ferran Sunyer i Balaguer announcement*

# Call for Nominations for 2016 IBC Prize

This annual prize is for outstanding achievement in information-based complexity. The prize consists of US$3,000 and a plaque. The award can be based on work done in a single year, in a number of years, or over a lifetime. The work can be published in any journal, number of journals, or monographs. Nominations may be sent to Joseph F. Traub at `traub@cs.columbia.edu`. However, a person does not have to be nominated to win the award. The deadline for nominations is **March 31, 2016**.

*—Joseph F. Traub, Columbia University*

# NSF Focused Research Groups

The Focused Research Groups (FRG) activity of the Division of Mathematical Sciences (DMS) of the National Science Foundation (NSF) supports projects for which the collective effort by a group of researchers in the mathematical sciences is necessary to reach the scientific goals. The deadline date for full proposals is **September 18, 2015**. The FRG program page may be found at `www.nsf.gov/funding/pgm_summ.jsp?pims_id=5671`.

*—From an NSF announcement*

# Joint DMS/NIGMS Initiative to Support Research at the Interface of the Biological and Mathematical Sciences

The Division of Mathematical Sciences (DMS) in the Directorate for Mathematical and Physical Sciences (MPS) at the National Science Foundation (NSF) and the National Institute of General Medical Sciences (NIGMS) at the National Institutes of Health support research in mathematics and statistics on questions in the biological and biomedical sciences. Both agencies recognize the need and urgency for promoting research at the interface between the mathematical sciences and the life sciences. This program is designed to encourage new collaborations, as well as to support existing ones. The deadline date for full proposals is **September 15, 2015**. For more information see the website `www.nsf.gov/funding/pgm_summ.jsp?pims_id=5300&org=NSF&sel_org=NSF&from=fund`.

*—From an NSF announcement*

# NSA Mathematical Sciences Grants Program

As the nation's largest employer of mathematicians, the National Security Agency (NSA) is a strong supporter of the academic mathematics community in the United States. Through the Mathematical Sciences Program, the NSA provides research funding in the mathematical sciences.

*Grants for Research in Mathematics.* The Mathematical Sciences Program (MSP) supports self-directed, unclassified research in the following areas of mathematics: Algebra, Number Theory, Discrete Mathematics, Probability, and Statistics. This year, following a policy announced on our website last year, the Research Grants program will accept proposals for Young Investigator Grants and proposals to support Conferences/Workshops/Special Situations (including Research Experiences for Undergraduates, as well as other innovative programs at a university in one of the five designated areas). The Young Investigator Grant is open to individuals who have completed the PhD

within the last ten years. The program does not entertain research or conference proposals that involve cryptology. In particular, the MSP is committed to supporting efforts that increase broader participation in the mathematical sciences, promote wide dissemination of mathematics, and promote the education and training of undergraduates and graduate students. Principal investigators, graduate students, and all other personnel supported by NSA grants must be US citizens or permanent residents of the United States at the time of the proposal submission. Proposals should be submitted electronically by **October 15, 2015**, via the program website: www.nsa.gov/research/math_research/index.shtml.

For more information about the Grants Program, please contact the program office at 443-634-4304. You may also send email to mspgrants@nsa.gov.

*—From an NSA Mathematical Sciences Program announcement*

# Research Experiences for Undergraduates

The Research Experiences for Undergraduates (REU) program supports active research participation by undergraduate students in any of the areas of research funded by the National Science Foundation (NSF). Student research may be supported in two forms: REU supplements and REU sites.

REU supplements may be requested for ongoing NSF-funded research projects or may be included in proposals for new or renewal NSF grants or cooperative agreements.

REU sites are based on independent proposals to initiate and conduct undergraduate research participation projects for a number of students. REU site projects may be based in a single discipline or academic department or may offer interdisciplinary or multidepartment research opportunities with a coherent intellectual theme. Proposals with an international dimension are welcome. Undergraduate student participants supported with NSF funds in either supplements or sites must be US citizens, US nationals, or permanent residents of the United States or its possessions.

Students may not apply to NSF to participate in REU activities. Students should apply directly to REU sites and should consult the directory of active REU sites on the Web at www.nsf.gov/crssprgm/reu/reu_search.cfm. The deadline for full proposals for REU sites is **August 26, 2015**. Deadline dates for REU supplements vary with the research program; contact the program director for more information. The full program announcement can be found at the website www.nsf.gov/funding/pgm_summ.jsp?pims_id=5517.

*—From an NSF announcement*

# Call for Nominations for Gerald Sacks Prize

The Association for Symbolic Logic (ASL) invites nominations for the Gerald Sacks Prize for the most outstanding doctoral dissertation in mathematical logic. The Sacks Prize consists of a cash award and five years' free membership in the ASL. The deadline for nominations is **September 30, 2015**, and dissertations must have been defended by that date. General information about the prize is available at www.aslonline.org/info-prizes.html. For details about nomination procedures, see www.aslonline.org/Sacks_nominations.html.

*—From an ASL announcement*

# Call for Nominations for AWM Falconer Lectureship

The Association for Women in Mathematics (AWM) and the Mathematical Association of America (MAA) annually present the Etta Z. Falconer Lecture to honor women who have made distinguished contributions to the mathematical sciences or mathematics education. These one-hour expository lectures are presented at MAA MathFest each summer. The deadline for nominations is **September 1, 2015**. For more information see the website https://sites.google.com/site/awmmath/programs/falconer-lectures.

*—From an AWM announcement*

# Call for Nominations for AWM Schafer Prize

The Association for Women in Mathematics (AWM) calls for nominations for the Alice T. Schafer Mathematics Prize to be awarded to an undergraduate woman for excellence in mathematics. The nominee may be at any level in her undergraduate career but must be an undergraduate when nominated. The deadline for nominations is **September 15, 2015**. For more information, see the website https://sites.google.com/site/awmmath/programs/schafer-prize.

*—From an AWM announcement*

# Mathematical Sciences Research Institute, Berkeley, CA

MSRI invites applications for forty Research Professors, two hundred Research Members, and thirty semester-long Postdoctoral Fellows in the following programs:

**Geometric Group Theory** (August 15–December 16, 2016), **Analytic Number Theory** (January 17–May 26, 2017), and **Harmonic Analysis** (January 17–May 26, 2017). Research Professorships are intended for senior researchers who will be making key contributions to a program, including the mentoring of postdoctoral fellows, and who will be in residence for three or more months. Research Memberships are intended for researchers who will be making contributions to a program and who will be in residence for one or more months. Postdoctoral Fellowships are intended for recent PhDs. Interested individuals should carefully describe the purpose of their proposed visit and indicate why a residency at MSRI will advance their research program. To receive full consideration, application must be complete, including all letters of support, by the following deadlines: Research Professorships, **October 1, 2015**; Research Memberships, **December 1, 2015**; Postdoctoral Fellowships, **December 1, 2015**. Application information can be found at https://www.msri.org/web/msri/scientific/member-application.

It is the policy of MSRI actively to seek to achieve diversity in its programs and 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.

Programs funded by the National Science Foundation.

*—From an MSRI announcement*

# Modern Math Workshop 2015, Washington, DC

The nine NSF-funded US-based math institutes present the annual Modern Math Workshop (MMW) on **October 28–29 (Wednesday–Thursday)** in the Washington DC area. The MMW is part of the institutes' Mathematical Sciences Diversity Initiatives, and the workshop is a preconference activity of the SACNAS National Conference (Society for Advancement of Hispanics/Chicanos and Native Americans in Science; see sacnas.org/events/national-conf). The MMW includes two mini-courses for undergraduates and talks related to the research programs at the math institutes that would be of interest to graduate students and early-career researchers. The workshop is intended to encourage minority undergraduates to pursue careers in the mathematical sciences and to assist undergrads, graduate students, and recent PhDs in building their research networks. The MMW culminates on October 29 with a plenary lecture by Dr. Freeman Hrabowski, president of UMBC (The University of Maryland, Baltimore County). Minority undergraduates, graduate students, and postdocs are encouraged to attend the workshop. For more information and to register, please see www.msri.org/e/MMW2015.

*—From an MSRI announcement*

# Call for Nominations for PIMS Postdoctoral Fellowship Competition

The Pacific Institute for the Mathematical Sciences (PIMS) invites nominations of outstanding young researchers in the mathematical sciences for Postdoctoral Fellowships for the year 2016–2017.

Candidates must be nominated by a scientist or department affiliated with PIMS; please note that **application is by nomination only**.

The fellowships are intended to supplement support provided by the sponsor and are tenable at any of the PIMS Canadian member universities. Complete applications must be uploaded to MathJobs at: mathjobs.org/jobs/PIMS by **December 1, 2015**. For further information, visit: www.pims.math.ca/scientific/postdoctoral or contact: assistant.director@pims.math.ca.

*—From a PIMS announcement*

# Clay Research Conference and Workshops

The 2015 Clay Research Conference will be held **September 30** at the Mathematical Institute of the University of Oxford. The plenary speakers are:
Charles Fefferman (Princeton); Mike Hopkins (Harvard); Maryam Mirzakhani (Stanford); Andrei Okounkov (Columbia); Peter Scholze (Bonn).

The 2014 Clay Research Award will be presented to Maryam Mirzakhani for her many significant contributions to geometry and ergodic theory. The recipient of the 2015 Clay Research Award will also be announced.

Associated workshops will be held throughout the week of the conference, **September 28–October 2**:

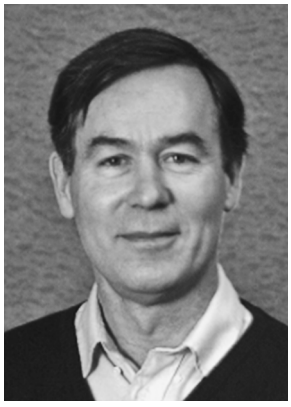
Algebraic Topology: Manifolds unlocking higher structures (Mike Hopkins and Ulrike Tillmann)

- Geometry and Dynamics of Moduli Spaces (Alex Eskin, Giovanni Forni, and Anton Zorich)
- Motives and Automorphic Forms (Minhyong Kim and Peter Scholze)
- Water Waves and Related Fluid Models (Alexandru Ionescu and Steve Shkoller)

**Registration for the Clay Research Conference is free, but required**. Participation in the workshops is by invitation. Limited accommodation is available for PhD students and early career researchers. For more information email Naomi Kraker at admin@claymath.org. For full details, see www.claymath.org.

*—From an MSRI announcement*

# For Your Information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Dr. Ian Hambleton

## Hambleton Appointed New Director of Fields Institute

The Fields Institute, after an exhaustive search and application process, has appointed Dr. Ian Hambleton, Britton Professor of Mathematics at McMaster University, as the new director of the Institute. The outgoing director, Dr. Walter Craig, will continue until June 30, 2015, and will assist in the transition. Dr. Hambleton will officially become the new director on July 1, 2015.

Dr. Hambleton received his doctorate from Yale University in 1973 and was an L. E. Dickson Instructor at the University of Chicago before joining McMaster University, where he has served as chair of the Department of Mathematics and Statistics for three terms, was active in university affairs as president of the McMaster Faculty Association, and was several times elected to the senate and board of governors. He is a prominent mathematician with more than seventy-five published articles in leading international journals and whose research in geometry and topology connects to a broad range of mathematics. His distinguished record of scholarship has been recognized by a high level of National Science and Engineering Research Council of Canada (NSERC) funding for almost forty years, supporting an extensive program of graduate and postdoctoral training. He was a member of the School of Mathematics at the Institute for Advanced Study in Princeton for two years and a visiting professor for three years at the Max Planck Institute for Mathematics in Bonn, in addition to numerous other visiting positions at major mathematical centers.

"The position of director at Fields is an exciting challenge. Walter's contributions to Fields have been outstanding, and I look forward to building on his accomplishments and those of all the past directors," said Dr. Hambleton.

The Director Search Committee was chaired by former Fields director Dr. Edward Bierstone, who said that "despite the very short search period, we were fortunate to have several excellent candidates, including Ian, with great ideas for advancing the mission of the Fields Institute. This is a testimony to the Institute's stature in the mathematical world. I am delighted that Ian has accepted the Institute's offer and that he is able to begin this summer."

Dr. Craig is very pleased at the selection of Dr. Hambleton as his replacement after he decided to step down for health reasons. "The Fields Institute is one of the top mathematical sciences research institutes in the world, and certainly one of the most active ones," he said. "It is very much due to the intellectual investment by the community into Institute events and programs, as well as the engagement of our staff. I am very sad to have to step down, but pleased on the other hand that Ian will be taking on the directorship. I have full confidence in his scientific judgement and his administrative skills."

The Fields Institute is an international center for research and training in all areas of the mathematical sciences and their applications. Every year its programs attract more than 4,000 participants from around the world. The Institute is supported by the Ontario Ministry of Training, Colleges and Universities, the Natural Sciences and Engineering Research Council of Canada, the US National Science Foundation, and a growing list of partner universities and corporations in Canada, the United States, and Europe.

*—Adam Zarboni*
*Communications Officer*
*The Fields Institute*

# Inside the AMS

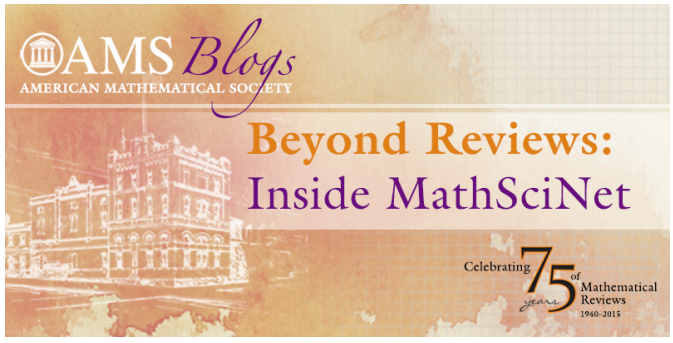
## Math in Moscow Scholarships Awarded

The AMS has made awards to six mathematics students to attend the Math in Moscow program in the fall of 2015. Following are the names of the undergraduate students and their institutions: CHLOE ONDRACEK, Minot State University; DEREK SORENSEN, Brigham Young University; ELISE MCMAHON, Ave Maria University; JIAWEI HAN, Indiana University Bloomington; KATRINA VELEZ, Florida International University; and SONG YU, Pomona College.

Math in Moscow is a program of the Independent University of Moscow that offers foreign students (undergraduate or graduate students specializing in mathematics and/or computer science) the opportunity to spend a semester in Moscow studying mathematics. All instruction is given in English. The fifteen-week program is similar to the Research Experiences for Undergraduates programs that are held each summer across the United States.

The AMS awards several scholarships for US students to attend the Math in Moscow program. The scholarships are made possible through a grant from the National Science Foundation. For more information about Math in Moscow, consult `www.mccme.ru/mathinmoscow` and the article "Bringing Eastern European Mathematical Traditions to North American Students," *Notices*, November 2003, pages 1250–4.

*—AMS Membership and Programs Department*




## From the AMS Public Awareness Office

**Beyond Reviews: Inside MathSciNet**. In this seventy-fifth year of *Mathematical Reviews*, executive editor Edward Dunne has started this AMS blog which highlights some of the features of MathSciNet, particularly informative reviews, and tips and tricks for navigating MathSciNet, all with the goal of being helpful to users both old and new. Dunne welcomes readers to comment on the posts, share favorite tricks and favorite reviews, and subscribe to the RSS feed to follow the blog. See `blogs.ams.org/beyondreviews/`.

**Vizzie Winners, a new album on Mathematical Imagery**. The National Science Foundation and *Popular Science* are cosponsors of the long-running Visualization Challenge, now called The Vizzies, to recognize some of the most beautiful visualizations from the worlds of science

and engineering. This album includes images of works by Richard Palais, University of California Irvine, and Luc Benard; Douglas N. Arnold and Jonathan Rogness, University of Minnesota, Twin Cities; Konstantin Poelke and Konrad Polthier, Free University of Berlin, among others. See www.ams.org/mathimagery.

**Reviews of books, plays, films, and television shows**. Find citations and links to reviews of books, plays, movies, and television shows that are related to mathematics (but are not aimed solely at the professional mathematician). The alphabetical list, updated on an ongoing basis, includes links to the sources of reviews posted online and covers reviews published in magazines, science journals, and newspapers since 1996. See www.ams.org/reviews.

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

# Deaths of AMS Members

RODNEY ANGOTTI, of DeKalb, Illinois, died on June 6, 2015. Born on August 14, 1937, he was a member of the Society for 50 years.

ANDREW LADISLAUS BARNES, of Niskayuna, New York, died on June 10, 2015. Born on September 14, 1968, he was a member of the Society for 22 years.

REBECCA BOONE, of Corvallis, Oregon, died on March 1, 2015. Born on October 25, 1921, she was a member of the Society for 14 years.

BURTIS G. CASLER, of Chamberlain, South Dakota, died on September 10, 2012. Born on June 9, 1927, he was a member of the Society for 50 years.

AKO HATTORI, professor emeritus, University of Tokyo, died on August 25, 2013. Born on June 18, 1929, he was a member of the Society for 50 years.

JOHN F. NASH JR., of Princeton Junction, New Jersey, died on May 23, 2015. Born on June 13, 1928, he was a member of the Society for 20 years.

PETER STANEK, of San Rafael, California, died on October 18, 2014. Born on December 3, 1937, he was a member of the Society for 54 years.

HOWARD SWANN, of Pacific Grove, California, died on May 18, 2015. Born on August 4, 1936, he was a member of the Society for 48 years.

MOUW-CHING TJIOK, of Germany, died on November 28, 2014. Born on May 13, 1942, he was a member of the Society for 36 years.

## Corrections

The *Notices* editors regret the following errors that appeared in the 2015 May issue:

On page 575 of the AMS Contributor's Report, Paul Pollack's donation should have been listed as a gift made in memory of Arnold Ross; Ellen Heiser's donation should have been listed as a gift made in memory of Paul Sally.

# Reference and Book List

*The* ***Reference*** *section is intended to provide readers with frequently sought information in an easily accessible format. New information is printed as it becomes available and is referenced after its first printing.*

## Contacting the *Notices*

The preferred method for contacting the *Notices* is email.

The **editor-in-chief**, **Steven G. Krantz**, should be contacted about articles for consideration. Articles include features, memorials, 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. Contact the **editor-in-chief** at: notices@math.wustl.edu.

The **managing editor**, **Rachel L. Rossi**, should be contacted for additions to "Mathematics People", "Mathematics Opportunities", "For Your Information", and for any corrections. Contact the **managing editor** at: notices@ams.org.

**Letters to the editor** should be sent to: notices-letters@ams.org.

**Permissions requests** should be sent to: reprint-permission@ams.org.

**Advertising requests** should be sent to: notices-ads@ams.org.

**Math Calendar** additions should be sent to: mathcal@ams.org.

**Book List** additions should be sent to: notices-booklist@ams.org.

*For full contact information, including postal addresses, see:* www.ams.org/notices/contact.html.

## 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, 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.

### Where to Find It

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


**AMS Bylaws**—*November 2013, p. 1358*

**AMS Email Addresses**—*February 2015, p. 179*

**AMS Governance 2015**—*June/July 2015, p. 673*

**Contact Information for Mathematical Institutes**—*August 2015, p. 837*

**Conference Board of the Mathematical Sciences**—*September 2014, p. 916*

**IMU Executive Committee**—*December 2014, p. 1370*

**Information for *Notices* Authors**—*August 2015, p. 835*

**National Science Board**—*January 2015, p. 71*

**NRC Board on Mathematical Sciences and Their Applications**—*March 2015, p. 290*

**NSF Mathematical and Physical Sciences Advisory Committee**—*May 2015, p. 571*

**Program Officers for Federal Funding Agencies**—*October 2013, p. 1188 (DoD, DoE); December 2014, p. 1369 (NSF Mathematics Education)*

**Program Officers for NSF Division of Mathematical Sciences**—*November 2014, p. 1264*

## *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 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 31, 2015**: Nominations for 2015 SASTRA Ramanujan Prize. See the website qseries.org/sastra-prize/nominations-2015.html.

**August 1, 2015**: Applications for Fulbright Postdoctoral Fellowships in Israel. See tinyurl.com/nzhcy6l.

**August 1, 2015**: Applications for August review for National Academies Research Associateship programs. See 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 26, 2015**: Full proposals for Research Experiences for Undergraduates (REU) sites. See "Mathematics Opportunities" in this issue.

**September 1, 2015**: Nominations for Association for Women in Mathematics (AWM) Falconer Lectureship. See "Mathematics Opportunities" in this issue.

**September 15, 2015**: Nominations for 2016 Abel Prize. See "Mathematics Opportunities" in this issue.

**September 15, 2015**: Full proposals for DMS/NIGMS Initiative to Support Research at the Interface of the Biological and Mathematical Sciences. See "Mathematics Opportunities" in this issue.

**September 15, 2015**: Nominations for Association for Women in Mathematics (AWM) Alice T. Schafer Prize. See "Mathematics Opportunities" in this issue.

**September 15, 2015**: Nominations for Sloan Research Fellowships. For more 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: www.sloan.org/sloan-research-fellowships/.

**September 15, 2015**: Applications for spring 2016 semester of Math in Moscow. See www.mccme.ru/mathinmoscow, or by writing to: 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 www.ams.org/programs/travel-grants/mimoscow , or by writing to: Math in Moscow Program, Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence RI 02904-2294; email: student-serv@ams.org.

**September 18, 2015**: Full proposals for NSF Focused Research Groups (FRG). See "Mathematics Opportunities" in this issue.

**September 30, 2015**: Nominations for ASL Gerald Sacks Prize. See "Mathematics Opportunities" in this issue.

**October 1, 2015**: 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, 2015**: Proposals for NSA Mathematical Sciences Grants Program. See "Mathematics Opportunities" in this issue.

**October 21, 2015**: Proposals for NSF Postdoctoral Research Fellowships. See www.nsf.gov/pubs/2012/nsf12496/nsf12496.htm.

**October 31, 2015**: Applications for Adams Prize for 2015–2016. See "Mathematics Opportunities" in this issue.

**November 1, 2015**: Applications for November review for National Academies Research Associateship programs. See 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.

**December 1, 2015**: Submissions for the John Riordan Prize of the OEIS Foundation. See the website https://oeis.org/wiki/RiordanPrize.

**December 3, 2015**: Nominations for 2016 Ferran Sunyer i Balaguer Prize. See "Mathematics Opportunities" in this issue.

**March 31, 2016**: Nominations for 2016 Information-Based Complexity Prize. See "Mathematics Opportunities" in this issue.

**April 15, 2016**: Applications for fall 2016 semester of Math in Moscow. See www.mccme.ru/mathinmoscow , or by writing to: 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 www.ams.org/programs/travel-grants/mimoscow, or by writing to: Math in Moscow Program, Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence RI 02904-2294; email: student-serv@ams.org

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www.aimath.org

**Stefan Banach International Mathematical Center**
8 Śniadeckich str., Room 426
00-656 Warszawa, Poland
Telephone: 48 22 522-82-32
Fax: 48 22 622-57-50
email: Banach.Center.Office@impan.pl
www.impan.gov.pl/BC

**Banff International Research Station**
University of British Columbia
4176-2207 Main Mall
Vancouver, BC V6T 1Z4, Canada
Telephone: 604-822-1649
Fax: 604-822-0883
email: birs-director@birs.ca
www.birs.ca

**Banff International Research Station**
c/o The Banff Centre
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email: birsmgr@birs.ca
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www.bcamath.org

**Center for Discrete Mathematics and Theoretical Computer Science (DIMACS)**
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Fax: 732-445-5932
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dimacs.rutgers.edu

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www.cscamm.umd.edu/

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**Tata Institute of Fundamental Research**
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**T. N. Thiele Centre for Applied Mathematics in Natural Science**
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**Warwick Mathematics Research Centre**
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www.maths.warwick.ac.uk/mrc/index.html

**Weierstrass Institute for Applied Analysis and Stochastics**
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www.wias-berlin.de/

## 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.*

**An * indicates a new addition to the book list.**

*Alan M. Turing: Centenary Edition,* by Sara Turing. Cambridge University Press, April 2012. ISBN-13: 978-11070-205-80. (Reviewed September 2014.)

*Alan Turing: The Enigma, The Centenary Edition,* by Andrew Hodges. Princeton University Press, May 2012. ISBN-13: 978-06911-556-47. (Reviewed September 2014.)

*Alan Turing: His Work and Impact,* edited by S. Barry Cooper and J. van Leeuwen. Elsevier, May 2013. ISBN-13: 978-01238-698-07. (Reviewed September 2014.)

*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. (Reviewed September 2014.)

*Arnold: Swimming Against the Tide,* edited by Boris A. Khesin and Serge L. Tabachnikov. AMS, September 2014. ISBN-13: 978-14704-169-97.

**Art in the Life of Mathematicians,* by Anna Kepes Szemerédi. American Mathematical Society, June 2015. ISBN-13: 978-1470419561.

*Automate This: How Algorithms Took Over Our Markets, Our Jobs, and the World,* by Christopher Steiner. Portfolio Trade August 2013. ISBN-13: 978-15918-465-29.

*Baroque Science,* by Ofer Gal and Raz Chen-Morris. University of Chicago Press, March 2013. ISBN-13: 978-02262-129-82.

*Beating the Odds: The Life and Times of E. A. Milne,* by Meg Weston. Imperial College Press, June 2013. ISBN-13: 978-18481-690-74.

*Beautiful Geometry,* by Eli Maor and Eugen Jost. Princeton University Press, January 2014. ISBN-13: 978-06911-509-94.

*Beyond Banneker: Black Mathematicians and the Paths to Excellence,* by Erica N. Walker. State University of New York Press, June 2014. ISBN-13: 978-14384-521-59.

**Birth of a Theorem: A Mathematical Adventure,* by Cédric Villani (translated from the French by Malcolm DeBevoise). Farrar, Straus and Giroux, April 2015. ISBN-13: 978-0865477674.

*Combinatorics: Ancient and Modern,* by Robin Wilson and John J. Watkins. Oxford University Press, August 2013. ISBN-13: 978-01996-565-92.

*The Computing Universe: A Journey through a Revolution,* by Tony Hey and Gyuri Pápay. Cambridge University Press, December 2014. ISBN-13: 978-05211-501-87.

*Constitutional Calculus: The Math of Justice and the Myth of Common Sense,* by Jeff Suzuki. Johns Hopkins University Press, January 2015. ISBN-13: 978-14214-159-56.

*A Curious History of Mathematics: The Big Ideas from Early Number Concepts to Chaos Theory,* by Joel Levy. Andre Deutsch, February 2014. ISBN-13: 978-02330-038-56.

*Doing Data Science: Straight Talk from the Frontline,* by Rachel Schutt and Cathy O'Neil. O'Reilly Media, November 2013. ISBN-13: 978-1-449-35865-5. (Reviewed October 2014.)

*Doing Mathematics: Convention, Subject, Calculation, Analogy*, by Martin H. Krieger. World Scientific, Second Edition, 2015. ISBN-13: 978-981-4571-83-8.

*Einstein's Dice and Schrödinger's Cat: How Two Great Minds Battled Quantum Randomness to Create a Unified Theory of Physics,* by Paul Halpern. Basic Books, April 2015. ISBN-13: 978-04650-757-13.

*Electricity and Magnetism for Mathematicians: A Guided Path from Maxwell's Equations to Yang-Mills,* by Thomas A. Garrity. Cambridge Uni-

versity Press, January 2015. ISBN-13: 978-11074-351-62.

*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. (Reviewed February 2015.)

*Experiencing Mathematics: What Do We Do, When We Do Mathematics?,* by Reuben Hersh. AMS, February 2014. ISBN-13: 978-0-8218-9420-0.

*The Fascinating World of Graph Theory,* by Arthur Benjamin, Gary Chartrand, and Ping Zhang. Princeton University Press, January 2015. ISBN-13: 978-06911-638-19.

*Fifty Visions of Mathematics,* edited by Sam Parc. Oxford University Press, July 2014. ISBN-13: 978-0-19-87-018-11.

*Finding Zero: A Mathematician's Odyssey to Uncover the Origins of Numbers,* by Amir D. Aczel. Palgrave Macmillan Trade, January 2015. ISBN-13: 978-11372-798-42.

*The Formula: How Algorithms Solve All Our Problems—And Create More,* by Luke Dormehl. Perigee Trade, November 2014. ISBN-13: 978-03991-705-39.

*From Mathematics in Logic to Logic in Mathematics: Boole and Frege,* by Aliou Tall. Docent Press, July 2014, ISBN-13: 978-0-9887449-7-4.

**Genius At Play: The Curious Mind of John Horton Conway,* by Siobhan Roberts. Bloomsbury USA, July 2015. ISBN-13: 978-1620405932.

*The Goddess of Small Victories,* by Yannick Grannec. Other Press, October 2014. ISBN-13: 978-15905-163-62.

*Great Mathematics Books of the Twentieth Century: A Personal Journal,* by Lizhen Ji. International Press of Boston, April 2014. ISBN-13: 978-15714-628-31.

*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 June/July 2014.)

*How to Bake Pi: An Edible Exploration of the Mathematics of Mathematics,* by Eugenia Cheng. Basic Books, May 2015. ISBN: 978-04650-517-17.

**How to Study as a Mathematics Major,* by Lara Alcock. Oxford University Press, January 2013. ISBN: 978-0-19-966131-2.

**How to Study for a Mathematics Degree,* by Lara Alcock. Oxford University Press, November 2012. ISBN: 978-0-19-966132-9.

*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. (Reviewed December 2014.)

*James Clerk Maxwell: Perspective on his Life and Works,* edited by Raymond Flood, Mark McCartney, and Andrew Whitaker. Oxford University Press, March 2014. ISBN-13: 978-0-19-96-643-75.

*Love and Math: The Heart of Hidden Reality,* by Edward Frenkel. Basic Books, October 2013. ISBN-13: 978-04650-507-41. (Reviewed October 2014.)

**The Magic Garden of George B and Other Logic Puzzles,* by Raymond M. Smullyan. World Scientific, April 2015. ISBN: 978-981-4675-05-5.

**The Magic of Math: Solving for x and Figuring Out Why,* by Arthur Benjamin. Basic Books. September 2015. ISBN-13: 978-0465054725.

*The Math Book: From Pythagoras to the 57th Dimension, 250 Milestones in the History of Mathematics,* by Clifford A. Pickover. Sterling, February 7, 2012. ISBN-13: 978-14027-882-91. (Reviewed April 2015.)

**Math Geek: From Klein Bottles to Chaos Theory, a Guide to the Nerdiest Math Facts, Theorems, and Equations,* by Raphael Rosen. Adams Media, June 2015. ISBN: 978-1440583810.

*Mathematical Understanding of Nature: Essays on Amazing Physical Phenomena and Their Understanding by Mathematicians*, by V. I. Arnold. AMS, September 2014. ISBN-13: 978-1-4704-170-17.

*The Mathematician's Shiva,* by Stuart Rojstaczer. Penguin Books, September 2014. ISBN-13: 978-0-14-312-631-7.

*Mathematics and the Making of Modern Ireland: Trinity College Dublin from Cromwell to the Celtic Tiger*, by David Attis. Docent Press, October 2014, ISBN-13: 978-0-9887449-8-1.

*Mathematics and the Real World: The Remarkable Role of Evolution in the Making of Mathematics*, by Zvi Artstein. Prometheus Books, September 2014. ISBN-13: 978-16161-409-15.

*The Mathematics Devotional: Celebrating the Wisdom and Beauty of Mathematics,* by Clifford Pickover. Sterling, November 2014. ISBN-13: 978-14549-132-21.

*The Mathematics of Love: Patterns, Proofs, and the Search for the Ultimate Equation,* by Hannah Fry. Simon & Schuster/TED, February 2015. ISBN: 978-14767-848-85.

*Mathematics without Apologies: Portrait of a Problematic Vocation,* by Michael Harris. Princeton University Press, January 2015. ISBN-13: 978-06911-542-37.

*A Mind For Numbers: How to Excel at Math and Science (Even If You Flunked Algebra),* by Barbara Oakley. Tarcher, July 2014. ISBN-13:978-03991-652-45.

*My Life and Functions,* by Walter K. Hayman. Logic Press, October 2014. Hardcover ISBN-13: 978-13260-322-41. Paperback ISBN-13: 978-1-326-03020-9. (Reviewed May 2015.)

*On Leibniz: Expanded Edition,* by Nicholas Rescher. University of Pittsburgh Press, June 2013. ISBN-13: 978-08229-621-82. (Reviewed in this issue.)

*Origins of Mathematical Words: A Comprehensive Dictionary of Latin, Greek, and Arabic Roots,* by Anthony Lo Bello. Johns Hopkins University Press, November 2013. ISBN-13: 978-14214-109-82.

*Parables, Parabolas and Catastrophes: Conversations on Mathematics, Science and Philosophy,* by René Thom. Translated by Roy Lisker and edited by S. Peter Tsatsanis. Thombooks Press, November 2014 (distributed only by `amazon.ca` or `amazon.com`). ISBN-13: 978-09939-269-07.

*Pearls from a Lost City: The Lvov School of Mathematics,* by Roman Duda (translated by Daniel Davies). AMS, July 2014. ISBN-13: 978-1-4704-107-66.

**Plato at the Googleplex: Why Philosophy Won't Go Away,* by Rebecca Newberger Goldstein. Pantheon, March 2015. ISBN: 978-0307378194.

*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. (Reviewed November 2014.)

*Professor Stewart's Casebook of Mathematical Mysteries,* by Ian Stewart. Basic Books, October 2014. ISBN-13: 978-04650-549-78.

*Quantum Computing since Democritus,* by Scott Aaronson. Cambridge University Press, March 2013. ISBN-13: 978-0-521-1-995-68. (Reviewed November 2014.)

**Reflections: The Magic, Music and Mathematics of Raymond Smullyan,* by Raymond M. Smullyan. World Scientific, April 2015. ISBN: 978-981-4644-58-7.

**The Scholar and the State: In Search of Van der Waerden,* by Alexander Soifer. Birkhäuser, January 2014. ISBN-13: 978-3034807111.

*The Simpsons and Their Mathematical Secrets,* by Simon Singh. Bloomsbury, October 2013. ISBN-13: 978-14088-353-02. (Reviewed January 2015.)

**Single Digits: In Praise of Small Numbers,* by Marc Chamberland. Princeton University Press, June 2015. ISBN-13: 978-0691161143.

*Struck by Genius: How a Brain Injury Made Me a Mathematical Marvel,* by Jason Padgett and Maureen Ann Seaberg. Houghton Mifflin Harcourt, April 2014. ISBN-13: 978-05440-456-06.

*Taming the Unknown: A History of Algebra from Antiquity to the Early Twentieth Century,* by Victor J. Katz and Karen Hunger Parshall. Princeton University Press, July 2014. ISBN-13: 978-06911-490-59.

*Turing: Pioneer of the Information Age,* by Jack Copeland. Oxford University Press, January 2013. ISBN-13: 978-0-19-96-397-93. (Reviewed September 2014.)

*The War of Guns and Mathematics: Mathematical Practices and Communities in France and Its Western Allies Around World War I,* by David Aubin and Catherine Goldstein. AMS, October 2014. ISBN-13: 978-1-4704-146-96.

*What's Math Got to Do with It?: How Teachers and Parents Can Transform Mathematics Learning and Inspire Success,* by Jo Boaler. Penguin Books, revised edition, March 2015. ISBN-13: 978-0-14-31-282-98.

*Why Is There Philosophy of Mathematics At All?,* by Ian Hacking. Cambridge University Press, April 2014. ISBN-13: 978-11070-501-74. (Reviewed December 2014.)

**Willful Ignorance: The Mismeasure of Uncertainty,* by Herbert I. Weisberg. Wiley, August 2014. ISBN: 978-0470890448.

*Zombies and Calculus*, by Colin Adams. Princeton University Press, September 2014. ISBN-13: 978-06911-619-07.

# Mathematics Calendar

Please submit conference information for the Mathematics Calendar through the Mathematics Calendar submission form at 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 www.ams.org/mathcal/.

## August 2015

* 3–5 **Workshop on Generalized Convexity and Set Computation**, Imperial College London, London, United Kingdom.
**Description:** The concept of generalized convexity can be regarded as a means to describe subsets of a Hilbert space in terms of generalized support functions. This representation seems promising from a theoretical as well as from a computational perspective, but its use for the characterization of set evolutions and set computation has not been examined. The idea behind this relatively small and specialized workshop is therefore to bring together experts for standard approaches to set computation, from generalized convexity and from bilevel optimisation to exchange ideas and assess in which way set computation can benefit from generalized convexity.
**Information:** wwwf.imperial.ac.uk/~mrasmuss/gcsc/

* 3–7 **Workshop on Invariants of Knots, Surfaces and 3-Manifolds**, Gazi University, Ankara, Turkey.
**Description:** The Workshop (August 3–7, 2015) precedes the Conference Invariants in Low Dimensional Geometry (August 10–14, 2015). Both are designed to bring together researchers and students working in low dimensional geometry and topology. The Workshop will consist of 6 short courses by an international team of experts in geometric, topological, arithmetic, group theoretic and quantum aspects of geometric topology. Lecturers BoGwang Jeon - Columbia University, Mustafa Korkmaz - Middle East Technical University, Kate Petersen - Florida State University, Saul Schleimer - Warwick Mathematics Institute, Mehmet Haluk Sengun - University of Sheffield, and Roland van der Veen - University of Amsterdam
**Information:** www.geometry-summer-school.gazi.edu.tr/

* 4–5 **Industrial Short Course: Robust Modeling in Process Optimization**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
**Description:** IPAM together with the German companies CiT, 8Berlin, and the Research Campus MODAL offers a two-day short course on introduction to the mathematical theory regarding uncertainty quantification, parameter estimation and model selection and validation. The resulting algorithms are discussed and applied to realistic examples from industrial research. The short course is for participants with scientific and technical background in the field of calibration or validation of mathematical models or model-driven data analysis in modelling, simulation and optimization of chemical processes. It is aimed at participants from the Chemical and Polymer Industry, Oil Industry, Pharma and Biotech Industry, Water Supply and Food Production. Topics will be adjusted depending on the exact interests of the participants. The number of participants will be limited to 20.
**Information:** www.ipam.ucla.edu/isc2015

* 4–6 **Summer School on Nonsmooth Dynamical Systems**, The University of Texas at Dallas, Richardson, Texas.
**Description:** The three courses of the school will describe modern tools that help understanding the dynamics of Elliptical Billiards, Switched Systems, and Hysteresis Phenomena. The elliptical billiards provide instructive examples of integrable systems; their dynamical properties follow from the geometry of pencils of conics and the arithmetic of related elliptic curves. The switched systems component will be centered around bifurcation theory, which proved to be a powerful tool in predicting limit cycles in anti-lock braking systems, passive walking robots, and other engineering models. Finally, the school will cover the infinite-dimensional operator framework required to model hysteresis phenomena that are common in plasticity, magnetism, friction, sorption, phase transitions, smart materials, biology and economics. Limited financial support is available for undergraduate and master students.
**Information:** www.utdallas.edu/ds2015/

* 10–14 **D-Modules in Commutative Algebra**, GIMAT, Guanajuato, Mexico.
**Description:** The theory of D-modules has become an indispensable tool in commutative algebra. Since its initial use to study local cohomology, D-modules have been used to study tight closure, F-jumping coefficients, hyperplane arrangements, Nakai conjecture, and in other commutative algebra contexts. On the other hand, these applications have also motivated important developments in the theory of D-modules itself. Some D-module-theoretic results that used to be known only in characteristic zero have been extended to

**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 in the Meetings & Conferences Section 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. 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 Editors of the *Notices* at 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*. New information about meetings and conferences that will occur beyond the current 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 given twelve-month period.
**The Mathematics Calendar,** as well as Meetings and Conferences of the AMS, is now available through the AMS website: www.ams.org/.

positive characteristic. In addition, Eulerian graded D-modules were introduced to study the graded structure of local cohomology modules of a polynomial ring over a field. Despite this progress, many questions remain open. This conference intends to expose commutative algebraists to techniques and new advancements in the world of D-modules, to bring experts in D-modules and in commutative algebra together to share ideas and develop collaborations in this area, and to increase awareness.
**Information:**
sites.google.com/site/dmodulesincommutativealgebra/home

* 10–14 **Invariants in Low Dimensional Geometry**, Gazi University, Ankara, Turkey.
**Description:** The conference entitled "Invariants in Low Dimensional Geometry," to be held on August 10–14, 2015, at Gazi University in Ankara, Turkey.
**Conference Organizers:** Abhijit Champanerkar (CUNY), Baki Karliga (Gazi University), Ilya Kofman (CUNY), Feng Luo (Rutgers University), Walter Neumann (Columbia University), and Murat Savas (Gazi University).
**Information:** www.math.csi.cuny.edu/abhijit/turkey2015/

* 13–14 **Illinois Number Theory Conference**, University of Illinois at Urbana-Champaign, Urbana, Illinois.
**Description:** A Number Theory Conference featuring a variety of topics in number theory will take place at the University of Illinois at Urbana-Champaign on August 13–14, 2015. About fifteen invited talks and more contributed talks are planned. This meeting continues a long tradition of conferences organized by the Number Theory group in the Department of Mathematics. Funding to defray travel costs for graduate students and junior faculty with no travel funding of their own is available. Also available is exceptional funding for women with young children for whom it is difficult to attend due to child-care issues. Please see conference website for details.
**Information:** math.uiuc.edu/nt2015

* 17–21 **Workshop on Algebraic Groups and Lie Algebras**, Bonne Bay Marine Station of Memorial University of Newfoundland in Norris Pont, Newfoundland, Canada.
**Description:** This workshop is the continuation of joint activity between the Atlantic Algebra Centre and the Network of Ontario Lie Theorists. This time we focus on the interrelations and various connections between the Lie theory and algebraic groups as well as on its applications to representation theory, graded algebras, superalgebras and quantum groups. We plan to attract about 25–30 participants from different countries. The schedule of the workshop will include several mini-courses given by leading experts addressed at young researchers, postdocs and graduate students, as well as research talks and short communications given by graduate students and postdocs.
**Information:** www.mun.ca/aac/Workshops/NextWork/AGLA2015.php

* 17–28 **George Boole Mathematical Sciences Conference**, University College Cork, Cork, Ireland.
**Description:** In honour of George Boole's bicentenary. Thematic sessions: (1) Quantum Information Theory (August 17–20); (2) Boole's algebra; Boolean algebra (August 27–28); (3) Complex and Boolean Networks (August 24–26); (4) Geometry and Visualization (August 26–28); (5) Harmonic Analysis (August 19–22); (6) Invariants from Moduli Spaces (August 24–27); (7) Mathematical Financial Modelling Post-Crisis (August 25–28); (8) Quantum Probabilistic Symmetries and Quantized Boolean Algebras (August 20–25); (9) Annual Meeting of the Irish Mathematical Society (August 27–28); (10) Domains XII Conference (August 25–28); (11) iRISC Consortium Meeting (August 31, 2015); (12) Boole meets Shannon Workshop (September 1–2, 2015)
**Information:** georgeboole.com/events/conferences/george-boole-mathematical-sciences-conference.html

* 18–23 **Tenth Summer School on Potential Theory**, Alfred Renyi Institute of Mathematics, Budapest, Hungary.
**Description:** The summer school is suitable for graduate and doctoral students, postdocs and researchers with an interest in potential theory. The aim of the summer school is to cover as large a part of the multifaceted theory as possible, by courses and lectures emphasizing the tutorial aspects and not merely the presentation of current personal achievements.
**Information:** www.renyi.hu/conferences/sspt

## September 2015

* 1–4 **Some Trends in Algebra 2015**, Fac. Math. Phys., Charles University, Prague 8, Karlin, Czech Republic.
**Description:** A conference on module theory and its relations to algebraic geometry, category theory, commutative algebra, homotopy theory, logic, and representation theory.
**Information:** www.karlin.mff.cuni.cz/~sta/sta15.html

* 8–12 **Mathematical Approaches for Traffic Flow Management Tutorials**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
**Description:** The long program opens with four days of tutorials that will provide an introduction to major themes of the entire program and the four workshops. The goal is to build a foundation for the participants of this program who have diverse scientific backgrounds.
**Topics:**
- A tutorial on estimation, including particle filtering, Kalman filtering, and model filtering.
- An introduction to traffic flow on networks.
- A primer on ramp metering, traffic signal, and/or variable speed limit control.
- A tutorial on utilizing new (and big) datasets.
Registration for tutorials is free, to encourage broad participation. The application for funding deadline is July 15, 2015.
**Information:** www.ipam.ucla.edu/tratut

* 10 –12 **International Conference on Special Functions and Applications - ICSFA 2015**, Amity University, Noida, India.
**Description:** International Conference on Special Functions and Applications - ICSFA 2015 is the XIVth Annual Meeting of the Society for Special Functions and their Applications. The three-day conference ICSFA-2015 aims to bring together the researchers working in the area of Special Functions and related areas for interaction and exchange of ideas. In addition, it will inspire young researchers to pursue research in this important branch of Mathematical sciences. The Academic program of the conference will consist of Plenary sessions, Invited Talks and Paper Presentations covering a wide range of topics including Special Functions, Hypergeometric function and its generalizations, Orthogonal polynomials, Lie theoretic approach to Special function, Ramanujan Mathematics, Fractional calculus, Combinatorics, Number theory, $q$-series and continued fractions, complex function theory, applications of special functions to Statistics, Physical sciences and Engineering.
**Information:** ssfaindia.webs.com/conf.htm

* 14–15 **The 2015 International Conference on Mathematics, its Applications, and Mathematics Education (ICMAME 2015)**, Sanata Dharma University, Yogyakarta, Indonesia.
**Description:** The 2015 International Conference on Mathematics, its Applications, and Mathematics Education (ICMAME 2015) is conducted to bring together mathematicians and other scientists working on new trends of mathematics, physics, its applications and also in mathematics education. The aim of this conference is to promote research interests in different fields of mathematics, physics as well as in mathematics education. The scientific program will include invited lectures and contributed talks.
**Information:** www.icmame.org

* 14–18 **Summer School on Thermodynamic Formalism and Transfer Operator Method**, University of Göttingen, Institute of Mathematics, Bunsenstr. 3-5, D-37073 Göttingen, Germany.
**Description:** This is the first event of a new series of summer schools on dynamical approaches in spectral geometry. It will discuss Thermodynamic Formalism and Transfer Operator Method, a field which has produced in recent years a lot of new results of interest in mathematical physics (quantum chaos), spectral geometry, harmonic analysis and number theory. The main speakers are: Oscar Bandtlow (Queen Mary London), Frédéric Naud (Avignon), Anke Pohl (Göttingen), and Julia Slipantschuk (Queen Mary London).
**Information:** www.uni-math.gwdg.de/Spirit2015

## October 2015

* 30–November 1 **Meeting of the History and Pedagogy of Mathematics, Americas Section**, University of Massachusetts, Amherst, Massachusetts.
**Description:** HPM-Americas is pleased to announce a meeting Friday afternoon through Sunday morning, October 30 to November 1, 2015, at the University of Massachusetts, Amherst. Amherst is located just off Rte. 91, and north of the Mass Pike. Amherst is accessible from the Hartford airport (50 minutes) and the Boston and Albany airports (each about 2 hours). A shuttle is available from the Hartford and Boston airports through Valley Transporter. Peter Pan bus lines runs from Boston, New York, and DC to the UMass campus. The nearest Amtrak station is in Northampton, which is about 10 miles from Amherst and on public transportation. We seek a variety of talks on relations between the history and pedagogy of mathematics. Talks on experience with using history in mathematics classrooms are especially encouraged. Talks seeking comment on untested ideas for using history to teach mathematics are also welcome. Talks will be about 25 minutes long, followed by abundant time for discussion. Abstracts of proposed talks need to be received by September 1, 2015.
**Information:** Abstracts and registrations can be submitted via www.hpm-americas.org.

## November 2015

* 5–6 **Workshop on $q$-Calculus and its Applications**, Universidad de Cundinamarca, Sede Principal Fusagasuga, Cundinamarca, Colombia.
**Description:** The aim of this mathematical meeting is to gather a group of people interested in studying and applying techniques from $q$-calculus to any branch of mathematics and science. Among the topics of interest we include quantum groups, $q$-probabilities, combinatorial $q$-analogues, Rota-Baxter $q$-algebras, categorification of $q$-calculus, knot theory, $q$-differential equations, $q$-deformations of algebras, Weyl $q$-algebras, Hecke algebras, Gaussian $q$-distribution.
**Information:** sites.google.com/site/workshopqcalculus/

* 6–8 **Ninth Annual Mathematical Field of Dreams Conference**, Sheraton Birmingham Hotel, Birmingham, Alabama.
**Description:** The National Alliance for Doctoral Studies in the Mathematical Sciences is pleased to announce the Ninth Annual Mathematical Field of Dreams Conference. This year the conference will be held at the Sheraton Birmingham Hotel located in Downtown Birmingham, Alabama. The Conference brings together faculty in the mathematical sciences with students from backgrounds underrepresented in those fields. This will be an exciting weekend that will provide something for everyone.
**Information:** mathalliance.org/?page_id=6154

* 9–11 **Equilibrium and Optimization Methodology in Finance and Economics (ICEOMFE 2015)**, King Saud University, Riyadh, Saudi Arabia.
**Description:** The main aim of this conference is to bring together leading experts and researchers in mathematical modeling to assess new developments in optimization and equilibria methodology and their applications to Mathematical Finance and Economics. The conference will focus on the following areas:
- Iterative Methods in Optimization and Fixed Point Theory
- Equilibrium theory
- Financial Markets
- Actuarial Mathematics
**Keynote Speakers:** B. Cornet (France), R. T. Rockafellar (USA), H. M. Soner (Switzerland), Hong-Kun Xu (China), Michel Thera (France).
**Invited Speakers:** H. Ben-El Mechaiekh (Canada), J-M. Bonnisseau (France), Alain Chateauneuf (France), P. Gourdel (France), A. Jofre (Chile), C. Le Van (France), A. Khan (Saudi Arabia), V. Radulescu (Romania), J. Sun (Australia).
**Local Organizer:** Souhail Chebbi (schebbiu@KSU.EDU.SA).
**Information:** npst.ksu.edu.sa/en/iceomfe/about

* 10–11 **ICMCS 2015 - International Conference on Mathematics and Computer Science**, Conference Hall Grand Hotel, Vienna, Austria.
**Description:** The aim of the conference is to promote research in the field of Mathematics and Computer Science. Another goal is to facilitate exchange of new ideas in these fields and to create a dialogue between scientists and practitioners.
**Keynote Speaker:** Professor of Pace University—Bel G. Raggad.

* 14–17 **IEEE Call for Papers**, The IEEE International Conference on Data Mining series Atlantic City, NJ.
**Description:** (ICDM) has established itself as the world's premier research conference in data mining. Paper submissions for the conference should be limited to a max of ten (10) pages in the IEEE 2-column format (templates available at www.ieee.org/conferences_events/conferences/publishing/templates.html), including the bibliography and any possible appendices. Manuscripts must be submitted electronically (wi-lab.com/cyberchair/2015/icdm15/cbc_index.php). Author names and affiliations must not appear in the submissions, and bibliographic references must be adjusted.
**Important Dates:**
* Full paper submissions: June 3, 2015
* Demo and tutorial proposals: July 13, 2015
* Conference paper, tutorial, demo notification: August 25, 2015
* Workshop paper submissions: August 28, 2015
* Workshop paper notifications: September 25, 2015
**Information:** www.ieee.org

## December 2015

* 7–11 **BioInfoSummer 2015**, The University of Sydney, Sydney, Australia.
**Description:** Bioinformatics, is an exciting, fast-moving area of analysing and simulating the structures and processes of biological systems. BioInfoSummer provides bioinformatics training to students, researchers and others working in related areas. The 2015 event includes both specialist lectures and hands on introductory and advanced computer workshops. Topics discussed will include: Introduction to Biology and Bioinformatics, Epigenomics, Translational Genomics, Proteomics and Metabolomics, Systems Biology, Networks and Data Integration.
**Information:** bis15.amsi.org.au/

* 16–18 **Stochastic Limit Analysis for Reacting Particle Systems**, Weierstrass Institute for Applied Analysis and Stochastics, Berlin, Germany.

**Description:** The workshop aims to present and facilitate discussion of approaches to systems of many particles, which at some level of modelling undergo spatial motion and stochastically interact when they collide or at least get very close. Classic applications of such systems include gas dynamics, particle coagulation and chemical reactions, but zoological and other application areas will also be considered. Alongside strong law of large numbers type results the workshop will showcase methods for obtaining further information to complement a characteristic limiting equation.
**Information:**
www.wias-berlin.de/workshops/ReactingParticles/

* 17–19 **International Workshop on Calculus of Variations and its Applications on the Occasion of Luisa Mascarenhas' 65th Birthday**, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, Caparica, Portugal.
**Description:** The aim of the workshop is both to bring together experts on Calculus of Variations and its applications, promoting the exchange of ideas and attracting young scientists to the field, and also to honor Professor Lulsa Mascarenhas, recently retired, for her contribution to Science. The workshop will take place at Faculdade de Ciências e Tecnologia, Campus de Caparica. There will be several talks by eminent researchers covering a wide range of methods to treat problems in Engineering, Mechanics and Life Sciences. Several of the invited speakers have directly collaborated with Professor Luísa Mascarenhas. Besides the lectures delivered by the invited speakers, we also plan to have a restricted number of contributed talks and a poster session.
**Information:** eventos.fct.unl.pt/cvamascar/

* 17–19 **National Conference on Emerging Trends in Mathematics and Mathematical Sciences (NCETMMS-2015)**, Calcutta Mathematical Society, Asutosh Bhavan, AE-374, Sector-I, Salt Lake City, Kolkata-700064, West Bengal, India.
**Description:** The Calcutta Mathematical Society (CMS) was founded in 1908 under the image of the London Mathematical Society. It is one of the oldest learned societies of its kind in Asia and had a long-standing association with many illustrious mathematicians and scientists. The main objective of NCETMMS-2015 is to bring together young and senior researchers and scientists in the fields of various branches of Mathematics and sciences which are considerably dependent on Mathematics. This will provide a platform where scientists can exchange their views and share their experiences regarding the latest developments in their respective fields of specialization. The thrust areas are:
i) Analysis
ii) Algebra
iii) Geometry and Relativity
iv) Dynamical Topology
v) Computational Fluid Dynamics
vi) Astrophysics and Space Science
vii) Ecology and Environment
viii) Information Theory
ix) Plasma and Magneto Hydrodynamics.
Deadline for receiving abstract August 31, 2015.
**Information:** www.calmathsoc.org

* 21–23 **7th WMVC-2015 (A National Conference on Wave Mechanics and Vibrations)**, Indian School of Mines, Dhanbad, India.
**Description:** 7th WMVC-2015 is one of the conference series on wave mechanics and vibrations. This national conference will be held during December 21, 2015 to December 23, 2015 at Indian School of Mines (Announced to be upgraded as Indian Institute of Technology) Dhanbad, India. This conference covers the topics like: Computational and Mathematical methods in Science and Technology, Solid Mechanics, Fluid dynamics, Theoretical astrophysics and Celestial mechanics, Numerical methods, Differential equations and Mathematical modeling. Several renowned experts from top organizations/institutes will be keynote speakers in this conference. This conference provides a unified stage to the academicians/researchers of both science and technology. Indian School of Mines will host this conference with the collaboration with Von Karman Society, Jalpaiguri, India.

* 27–29 **Modern Mathematical Methods And High Performance Computing in Science & Technology (M3HPCST-2015)**, Department of Mathematics Raj Kumar Goel Institute of Technology NH-58 Delhi-Meerut Road, Ghaziabad UP 201003, INDIA.
**Description:** The goal of this conference is to explore multi-disciplinary research. It focuses on algorithms development and implementation of Modern Mathematical Methods and High Performance Computing by Scientists, Researchers and Engineers. Current research in computational science requires multi-disciplinary knowledge, not only in sciences and engineering but also in technologies of computing. This conference offers academic researchers, developers and practitioners an opportunity to discuss various aspects of computational science and engineering related problems solving techniques for science and engineering research. The focus area will include, but not be limited to: Computational Methods for Linear and Non Linear Optimization, Mathematical Models, Mathematical Modeling and Computational Techniques, Functional Analysis, Operation Theory, Approximation Theory, Algebraic Coding Theory, Number Theory, Image and Signal Processing, Computational Biology, High Performance Computing, Advance Numerical Methods.
**Important Dates:** Receipt of Abstract July 15, 2015
Intimation of Acceptance of Abstract July 25, 2015
Submission of full length paper (Max. 8 Pages) - August 30, 2015
Notification of review comments - November 10, 2015
Final submission in camera ready format - November 30, 2015
Date of the Conference - December 27–29, 2015.
**Information:** www.rkgit.edu.in/m3hpcst-2015.php

* 28–31 **Ninth International Triennial Calcutta Symposium on Probability and Statistics**, Department of Statistics, University of Calcutta, 35 Ballygunge Circular Road, Kolkata 700019, West Bengal, India
**Description:** Organised by the Department of Statistics, University of Calcutta and Calcutta Statistical Association, the ninth edition of the Symposium will feature special sessions; invited and contributory sessions on Theoretical and Applied Statistics and Probability; and poster sessions for students and young researchers. Best posters will be awarded. Sponsored posters from industries will also be entertained. As in previous editions, special lectures on Design of Experiments in memory of late Professor R. C. Bose and on Multivariate Analysis in memory of late Professor S. N. Roy will be held during the symposium.
**Keynote Speaker:** Professor Sheldon M. Ross, University of California at Berkeley.
**S. K. Chakravarti Memorial Speaker:** Professor Sabina Alkire, Oxford University.
**Deadlines:** Abstracts: June 30, 2015; Early registration: October 31, 2015.
**Information:**
calcuttastatisticalassociation.org/triennial/symp-Brochure.php

## February 2016

* 2–6 **36th Linz Seminar on Fuzzy Set Theory "Functional Equations and Inequalities"**, St. Magdalena, Linz, Austria.
**Description:** Since their inception in 1979 the Linz Seminars on Fuzzy Set Theory have emphasized the development of mathematical aspects of fuzzy sets by bringing together researchers in fuzzy sets and established mathematicians whose work outside the fuzzy setting can provide direction for further research. The philosophy of the seminar has always been to keep it deliberately small and intimate so that informal critical discussions remain central. LINZ 2016 will be the 36th seminar carrying on this tradition and is devoted to the theme "Functional Equations and Inequalities." The goal of the seminar is to present and to discuss recent advances on (algebraic) functional equations and inequalities and their applications in pure and applied mathematics, with special emphasis on many-valued logics, multicriteria decision aid and preference modelling. LINZ 2016 is organized by the Department of Knowledge-Based Mathematical Systems of the Johannes Kepler University Linz, Austria.
**Information:** www.flll.jku.at/linzseminars

* 22–26 **Algebraic Geometry for Coding Theory and Cryptography**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
**Description:** Coding theory and cryptography are important in everyday life, because they form some of the building blocks of

e-commerce. Error-correction via coding theory protects information as it is stored or sent, and efficient error-correction may provide significant benefits and cost-savings for enterprise. Cryptographic systems are necessary to secure information in storage, transmission, and interaction, and provide both confidentiality and authenticity guarantees. While there has always been significant and fruitful interaction between algebraic geometry and both coding theory and cryptography, new directions in coding theory—such as locally decodable codes, codes for distributed storage systems, and network coding—suggest the possibility of new connections with algebraic geometry. Participants will spend one week working together in small groups on one of six projects related to the theme of the workshop.
**Information:**
Apply at www.mathprograms.org/db/programs/369
URL: www.ipam.ucla.edu/agc2016

## March 2016

* 12–13 **6th Ohio River Analysis Meeting (ORAM 6)**, University of Kentucky, Lexington, KY.
**Description:** ORAM is an annual event jointly sponsored by mathematicians at the University of Cincinnati and the University of Kentucky highlighting research in analysis and partial differential equations. ORAM 6 is hosted by the University of Kentucky. The confirmed invited speakers are Scott Armstrong (Université Paris-Dauphine), Hans Lindblad (Johns Hopkins University), Camil Muscalu (Cornell University), Malabika Pramanik (University of British Columbia), and Monica Visan (UCLA). There will be 20–25 contributed talks, with priority given to young mathematicians and those from underrepresented groups. Travel support is available through a grant from the National Science Foundation. Please see the website for registration and details.
**Information:** math.as.uky.edu/oram6

## April 2016

* 11–15 **Workshop II: Culture Analytics and User Experience Design**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
**Description:** Culture analytics concerns itself with the highly interwoven and complex interactions among individuals, society, and technology that are catalyzed by the enormous growth in data that characterizes the current age. User experience design requires more than a thin interface veneer on top of an algorithmic layer. The shape of the user experience must be rooted in the computational structure from the beginning and co-designed along with the statistical and machine learning algorithms for data exploration and analysis. In order to best design the next generation of technologies to enhance communication, collaboration, and cultural understanding, and to prepare for unintended consequences, we need to incorporate a robust understanding of human and social capabilities with deep technical and mathematical skills. To accomplish this, researchers, developers, and designers must demonstrate a willingness to transcend disciplinary concerns. The funding application deadline is February 15, 2016.
**Information:** www.ipam.ucla.edu/caws2

## June 2016

* 6–10 **AIM Workshop: Markov chain mixing times**, American Institute of Mathematics, San Jose, California.
**Description:** This workshop, sponsored by AIM and the NSF, will be devoted to new connections between the topic of Markov chain mixing times and other subareas of modern probability theory.
**Location:** aimath.org/workshops/upcoming/markovmixing

* 27–July 1 **AIM Workshop: Representation Stability**, American Institute of Mathematics, San Jose, CA.
**Description:** This workshop, sponsored by AIM and the NSF, will be devoted to recent developments in representation stability. Among these developments are results on algebraic and combinatorial aspects of functor categories and stable representation categories, and the use of "large" algebraic structures on limit objects to obtain finiteness results.
**Location:** aimath.org/workshops/upcoming/repnstability

* 27–July 1 **Optimal and Random Point Configurations: From Statistical Physics to Approximation Theory**, Institut Henri Poincaré, Paris, France.
**Description:** This conference aims at bringing together the communities of probabilists, statistical physicists, approximation theorists, and analysts, who work with different points of view on issues of optimal and random point configurations such as Fekete sets, Coulomb gases, point processes arising in random matrices, and crystallization questions. Particular attention will be given to the lectures being accessible to young researchers and a poster session will be organized.
**Location:** djalil.chafai.net/wiki/ihp2016:start

## July 2016

* 3–8 **Conference on Rings and Polynomials**, Graz University of Technology, Graz, Austria.
**Description:** Continuing the series of ring-theory conferences in Graz 2012 and 2014. Rings, algebras and polynomials, with emphasis on: Integer-valued polynomials; Polynomial functions; Multiplicative ideal theory Factorization theory in rings and semigroups; Module theory and linear algebra over rings; Homological algebra; Pruefer domains and related topics; Zariski-Riemann spaces of valuation domains.
**Invited Speakers:** Silvana Bazzoni (Univ. of Padova, Italy), Paul-Jean Cahen (Univ. Aix-Marseille III, France), Mátyás Domokos (Hungarian Acad. Sci.), Mi Hee Park [unconfirmed] (Chung-Ang Univ., Korea), Hans Schoutens (CUNY, USA), Nicholas Werner (SUNY, USA).
**Location:** integer-valued.org/conf2016/

**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.**

## September 2016

* 26–30 **Machine Learning Meets Many-Particle Problems**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
**Description:** This workshop will set the stage and define research directions for the rest of the program. The idea is to achieve a healthy mix between mathematicians, computer scientists, physicists, and chemists and establish common grounds that will enable rational applications of machine learning techniques to many-particle problems. One prominent outcome of this workshop will be the establishment of a common repository of datasets corresponding to different many-particle problems (structures and energies of molecules and materials, protein structures and dynamics, spectroscopic signatures of complex systems, etc.). These datasets can be used to assess the performance of different ML techniques during the IPAM program and beyond. The application deadline for funding is August 1, 2016.
**Information:** www.ipam.ucla.edu/mpsws1

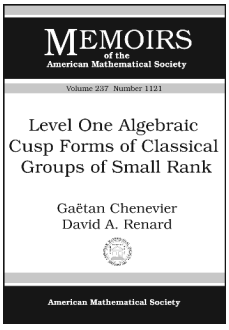
## July 2017

* 30–August 4 **Current Trends in Dynamical Systems and the Mathematical Legacy of Rufus Bowen**, University of British Columbia, Vancouver, BC, Canada.
**Description:** The conference will focus on areas of current interest that are broadly related to the work of Rufus Bowen.
**Information:** www.math.ubc.ca/~marcus/RBowenConference/

# New Publications Offered by the AMS

*To subscribe to email notification of new AMS publications, please go to* www.ams.org/bookstore-email.

## Algebra and Algebraic Geometry



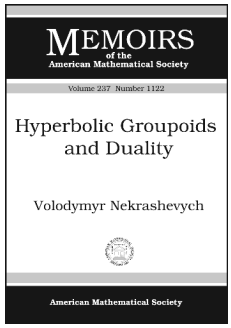

### Level One Algebraic Cusp Forms of Classical Groups of Small Rank

**Gaëtan Chenevier** and **David A. Renard**, *Centre de Mathématiques Laurent Schwartz, Ecole Polytechnique, Palaiseau, France*

**Contents:** Introduction; Polynomial invariants of finite subgroups of compact connected Lie groups; Automorphic representations of classical groups : review of Arthur's results; Determination of $\Pi^{\perp}_{\mathrm{alg}}(\mathrm{PGL}_n)$ for $n \leq 5$; Description of $\Pi_{\mathrm{disc}}(\mathrm{SO}_7)$ and $\Pi^{\mathrm{s}}_{\mathrm{alg}}(\mathrm{PGL}_6)$; Description of $\Pi_{\mathrm{disc}}(SO_9)$ and $\Pi^{\mathrm{s}}_{\mathrm{alg}}(\mathrm{PGL}_8)$; Description of $\Pi_{\mathrm{disc}}(\mathrm{SO}_8)$ and $\Pi^{\mathrm{o}}_{\mathrm{alg}}(\mathrm{PGL}_8)$; Description of $\Pi_{\mathrm{disc}}(\mathrm{G}_2)$; Application to Siegel modular forms; Appendix A. Adams-Johnson packets; Appendix B. The Langlands group of $\mathbb{Z}$ and Sato-Tate groups; Appendix C. Tables; Appendix D. The 121 level 1 automorphic representations of $SO_{25}$ with trivial coefficients; Bibliography.

**Memoirs of the American Mathematical Society**, Volume 237, Number 1121

August 2015, 122 pages, Softcover, ISBN: 978-1-4704-1094-0, LC 2015016272, 2010 *Mathematics Subject Classification:* 11Fxx; 11F46, 11F55, 11F70, 11F72, 11F80, 11G40, 11R39, 11Y55, 22C05, **Individual member US$48.60**, List US$81, Institutional member US$64.80, Order code MEMO/237/1121



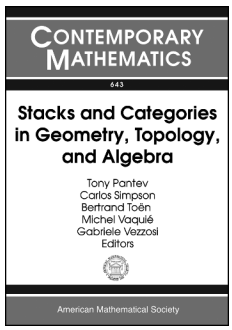

### Hyperbolic Groupoids and Duality

**Volodymyr Nekrashevych**, *Texas A&M University, College Station, Texas*

**Contents:** Introduction; Technical preliminaries; Preliminaries on groupoids and pseudogroups; Hyperbolic groupoids; Smale quasi-flows and duality; Examples of hyperbolic groupoids and their duals; Bibliography; Index.

**Memoirs of the American Mathematical Society**, Volume 237, Number 1122

August 2015, 108 pages, Softcover, ISBN: 978-1-4704-1544-0, LC 2015016273, 2010 *Mathematics Subject Classification:* 37D20, 20L05; 20F67, **Individual member US$48**, List US$80, Institutional member US$64, Order code MEMO/237/1122




### Stacks and Categories in Geometry, Topology, and Algebra

**Tony Pantev**, *University of Pennsylvania, Philadelphia, PA*, **Carlos Simpson**, *Université Nice Sophia Antipolis, France*, **Bertrand Toën**, *Université de Montpellier 2, France*, **Michel Vaquié**, *Université Paul Sabatier, Toulouse, France*, and **Gabriele Vezzosi**, *Università degli Studi di Firenze, Italy*, Editors

This volume contains the proceedings of the CATS4 Conference on Higher Categorical Structures and their Interactions with Algebraic Geometry, Algebraic Topology and Algebra, held from July 2–7, 2012, at CIRM in Luminy, France.

Over the past several years, the CATS conference series has brought together top level researchers from around the world interested in relative and higher category theory and its applications to classical mathematical domains.

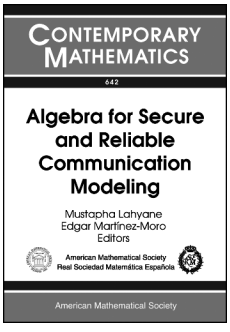
Included in this volume is a collection of articles covering the applications of categories and stacks to geometry, topology and algebra. Techniques such as localization, model categories, simplicial objects, sheaves of categories, mapping stacks, dg structures, hereditary categories, and derived stacks are applied to give new insight on cluster algebra, Lagrangians, trace theories, loop spaces, structured surfaces, stability, ind-coherent complexes and 1-affineness showing up in geometric Langlands, branching out to many related topics along the way.

**Contents: D. Calaque**, Lagrangian structures on mapping stacks and semi-classical TFTs; **J. E. Bergner** and **M. Robertson**, Cluster categories for topologists; **T. Dyckerhoff** and **M. Kapranov**, Crossed simplicial groups and structured surfaces; **G. Vezzosi**, A model structure on relative dg-Lie algebroids; **O. Ben-Bassat**, Multiple derived Lagrangian intersections; **D. Gaitsgory**, Sheaves of categories and the notion of 1-affineness; **D. Kaledin**, Trace theories and localization; **G. Dimitrov** and **L. Katzarkov**, Non-semistable exceptional objects in hereditary categories: Some remarks and conjectures; **A. Preygel**, Ind-coherent complexes on loop spaces and connections.

**Contemporary Mathematics**, Volume 643

July 2015, 323 pages, Softcover, ISBN: 978-1-4704-1557-0, LC 2014048031, 2010 *Mathematics Subject Classification:* 14D23, 14D05, 18E30, 18D05, 18D10, 18G30, 55P43, 57R56, 55U40, 81T45, **AMS members US$84**, List US$105, Order code CONM/643

# Discrete Mathematics and Combinatorics




## Algebra for Secure and Reliable Communication Modeling

**Mustapha Lahyane**, *Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Mexico*, and **Edgar Martínez-Moro**, *Universidad Valladolid, Soria, Spain*, Editors

This volume contains the proceedings of the CIMPA Research School and Conference on Algebra for Secure and Reliable Communication Modeling, held from October 1–13, 2012, in Morelia, State of Michoacán, Mexico.

The papers cover several aspects of the theory of coding theory and are gathered into three categories: general theory of linear codes, algebraic geometry and coding theory, and constacyclic codes over rings.

The aim of this volume is to fill the gap between the theoretical part of algebraic geometry and the applications to problem solving and computational modeling in engineering, signal processing and information theory.

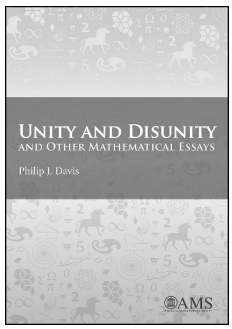
*This item will also be of interest to those working in applications.*

**Contents: J. A. Wood**, Some applications of the Fourier transform in algebraic coding theory; **I. Márquez-Corbella** and **E. Martínez-Moro**, A semigroup approach to complete decoding; **C. Carvalho**, Gröbner bases methods in coding theory; **C. Munuera** and **W. Olaya-León**, An introduction to algebraic geometry codes; **J. I. Farrán** and **C. Galindo**, Evaluation codes and plane valuations; **B. L. De La Rosa Navarro**, **M. Lahyane**, and **E. Previato**, Vector bundles with a view toward coding theory; **B. L. De La Rosa Navarro** and **M. Lahyane**, Algebraic-geometric codes from rational surfaces; **B. Chen** and **H. Q. Dinh**, Equivalence classes and structures of constacyclic codes over finite fields; **H. Q. Dinh**, On repeated-root constacyclic codes of prime power length over polynomial residue rings.

**Contemporary Mathematics**, Volume 642

July 2015, 240 pages, Softcover, ISBN: 978-1-4704-1018-6, LC 2014047010, 2010 *Mathematics Subject Classification:* 11T71, 14G50, 14Q05, **AMS members US$84**, List US$105, Order code CONM/642

# General Interest




## Unity and Disunity and Other Mathematical Essays

**Philip J. Davis**, *Brown University, Providence, RI*

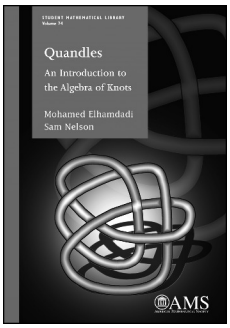
This book is a mathematical potpourri. Its material originated in classroom presentations, formal lectures, sections of earlier books, book reviews, or just things written by the author for his own pleasure. Written in a nontechnical fashion, this book expresses the unique vision and attitude of the author towards the role of mathematics in society. It contains observations or incidental remarks on mathematics, its nature, its impacts on education and science and technology, its personalities and their philosophies. The book is directed towards the math buffs of the world and, more generally, towards the literate and interested public.

Philip Davis is known for his work in numerical analysis and approximation theory, as well as his investigations in the history and philosophy of mathematics. Currently a Professor Emeritus from the Division of Applied Mathematics at Brown University, Davis is known for his books both in the areas of computational mathematics and approximation theory and for books exploring certain questions in the philosophy of mathematics and the role of mathematics in society.

**Contents:** The unity and disunity of mathematics; Evidence in mathematics; Out of what stuff do we make mathematics?; Computational experiences in the pre-electronic days; Spengler's mathematics considered and a Phoenix reborn?; Can the mathematical/physical notions of entropy be usefully imported into the social sphere?; The decline, fall, and current resurgence of visual geometry: Mathematics as a multisemiotic enterprise; The unicorn or mathematical ontology; Mathematics, politics, and law; The two culture controversy: A mathematician's view a half century later; Four literary men comment on mathematics: Henry James, George Santayana, Paul Valéry, and Isaiah Berlin; The media and mathematics look at each other; New winds blowing in applied mathematics.

August 2015, 149 pages, Softcover, ISBN: 978-1-4704-2023-9, LC 2015015348, 2010 *Mathematics Subject Classification:* 00A30, **AMS members US$31.20**, List US$39, Order code MBK/94

# Geometry and Topology




## Quandles

### An Introduction to the Algebra of Knots

**Mohamed Elhamdadi**, *University of South Florida, Tampa, FL*, and **Sam Nelson**, *Claremont McKenna College, CA*

From prehistory to the present, knots have been used for purposes both artistic and practical. The modern science of Knot Theory has ramifications for biochemistry and mathematical physics and is a rich source of research projects for undergraduate and graduate students and professionals alike. Quandles are essentially knots translated into algebra.

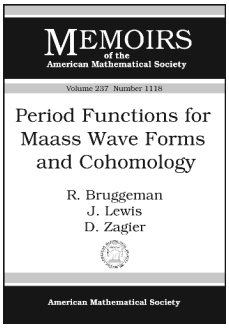
This book provides an accessible introduction to quandle theory for readers with a background in linear algebra. Important concepts from topology and abstract algebra motivated by quandle theory are introduced along the way. With elementary self-contained treatments of topics such as group theory, cohomology, knotted surfaces and more, this book is perfect for a transition course, an upper-division mathematics elective, preparation for research in knot theory, and any reader interested in knots.

**Contents:** Knots and links; Algebraic structures; Quandles; Quandles and groups; Generalizations of quandles; Enhancements; Generalized knots and links; Bibliography; Index.

**Student Mathematical Library**, Volume 74

August 2015, approximately 248 pages, Softcover, ISBN: 978-1-4704-2213-4, LC 2015012551, 2010 *Mathematics Subject Classification:* 57M25, 55M25, 20N05, 20B05, 55N35, 57M05, 57M27, 20N02, 57Q45, **AMS members US$39.20**, **All Individuals US$39.20**, List US$49, Order code STML/74

# Number Theory



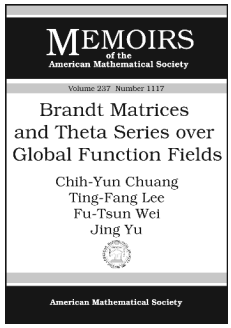

## Period Functions for Maass Wave Forms and Cohomology

**R. Bruggeman**, *Mathematisch Instituut, Universiteit Utrecht, The Netherlands*, **J. Lewis**, *Massachusetts Institute of Technology, Cambridge, Massachusetts*, and **D. Zagier**, *MPI for Mathematics, Bonn, Germany, and College de France, Paris, France*

**Contents:** Eigenfunctions of the hyperbolic Laplace operator; Maass forms and analytic cohomology: cocompact groups; Cohomology of infinite cyclic subgroups of $\mathrm{PSL}_2(\mathbb{R})$; Maass forms and semi-analytic cohomology: groups with cusps; Maass forms and differentiable cohomology; Distribution cohomology and Petersson product; Bibliography; Index; List of notations.

**Memoirs of the American Mathematical Society**, Volume 237, Number 1118

August 2015, 132 pages, Softcover, ISBN: 978-1-4704-1407-8, LC 2015016270, 2010 *Mathematics Subject Classification:* 11F37, 11F67; 11F75, 22E40, **Individual member US$48.60**, List US$81, Institutional member US$64.80, Order code MEMO/237/1118



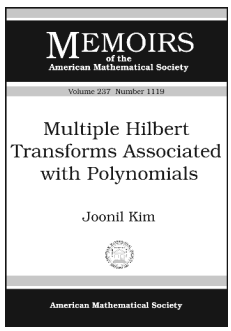

## Brandt Matrices and Theta Series over Global Function Fields

**Chih-Yun Chuang** and **Ting-Fang Lee**, *Taida Institute for Mathematical Sciences, Taipei, Taiwan*, **Fu-Tsun Wei**, *Institute of Mathematics, Academia Sinica, Taipei, Taiwan*, and **Jing Yu**, *National Taiwan University, Taipei, Taiwan*

**Contents:** Introduction; Brandt matrices and definite Shimura curves; The basis problem for Drinfeld type automorphic forms; Metaplectic forms and Shintani-type correspondence; Trace formula of Brandt matrices; Bibliography; Symbols.

**Memoirs of the American Mathematical Society**, Volume 237, Number 1117

August 2015, 64 pages, Softcover, ISBN: 978-1-4704-1419-1, LC 2015016268, 2010 *Mathematics Subject Classification:* 11R58, 11F27, 11F30, 11F37, 11F41, **Individual member US$40.80**, List US$68, Institutional member US$54.40, Order code MEMO/237/1117




## Multiple Hilbert Transforms Associated with Polynomials

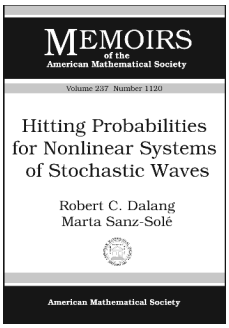
**Joonil Kim**, *Yonsei University, Seoul, South Korea*

**Contents:** Introduction; Definitions of polyhedra, their faces and cones; Main theorem and background; Combinatorial lemmas; Descending faces vs. ascending cones; Preliminary results of analysis; Proof of sufficiency; Necessity theorem; Preliminary lemmas for necessity proof; Proof of necessity; Proofs of Corollary 3.1 and main Theorem 3.1; Appendix; Bibliography.

**Memoirs of the American Mathematical Society**, Volume 237, Number 1119

August 2015, 120 pages, Softcover, ISBN: 978-1-4704-1435-1, LC 2015016266, 2010 *Mathematics Subject Classification:* 42B20, 42B25, **Individual member US$48.60**, List US$81, Institutional member US$64.80, Order code MEMO/237/1119

# Probability and Statistics




## Hitting Probabilities for Nonlinear Systems of Stochastic Waves

**Robert C. Dalang**, *Ecole Polytechnique Fédérale de Lausanne, Switzerland, and University of Barcelona, Spain*, and **Marta Sanz-Solé**, *University of Barcelona, Spain*

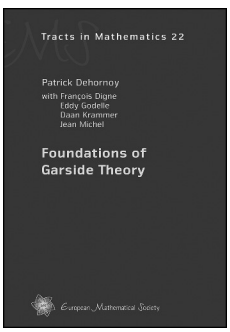
**Contents:** Introduction; Upper bounds on hitting probabilities; Conditions on Malliavin matrix eigenvalues for lower bounds; Study of Malliavin matrix eigenvalues and lower bounds; Appendix A. Technical estimates; Bibliography.

**Memoirs of the American Mathematical Society**, Volume 237, Number 1120

August 2015, 75 pages, Softcover, ISBN: 978-1-4704-1423-8, LC 2015016271, 2010 *Mathematics Subject Classification:* 60H15, 60J45; 60G15, 60H07, 60G60, **Individual member US$42**, List US$70, Institutional member US$56, Order code MEMO/237/1120

# New AMS-Distributed Publications

# Algebra and Algebraic Geometry




## Foundations of Garside Theory

**Patrick Dehornoy**, *University of Caen, France*
with François Digne, Eddy Godelle, Daan Krammer, and Jean Michel

This text is a monograph on algebra, with connections to geometry and low-dimensional topology. It mainly involves groups, monoids, and categories, and aims to provide a unified treatment for those situations in which one can find distinguished decompositions by iteratively extracting a maximal fragment lying in a prescribed family. Initiated in 1969 by F. A. Garside in the case of Artin's braid groups, this approach led to interesting results in a number of cases, the central notion being what the authors call a Garside family. The study is far from complete, and the purpose of this book is to present the current state of the theory and to invite further research.

The book has two parts: In Part A, the bases of a general theory, including many easy examples, are developed. In Part B, various more sophisticated examples are specifically addressed.

To make the content accessible to a wide audience of nonspecialists, the book's exposition is essentially self-contained and very few prerequisites are needed. In particular, it should be easy to use this as a textbook both for Garside theory and for the more specialized topics investigated in Part B: Artin–Tits groups, Deligne–Lusztig varieties, groups of algebraic laws, ordered groups, and structure groups of set-theoretic solutions of the Yang–Baxter equation. The first part of the book can be used as the basis for a graduate or advanced undergraduate course.

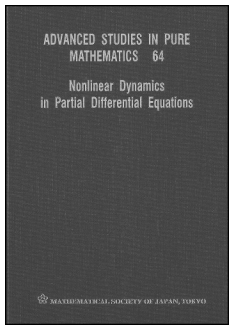
A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

**Contents:** For the table of contents, go to www.ams.org/bookstore.

**EMS Tracts in Mathematics**, Volume 24

May 2015, 710 pages, Hardcover, ISBN: 978-3-03719-139-2, 2010 *Mathematics Subject Classification:* 20Fxx, 20F05, 20F10, 20F36, 20F60, 20F65, 20M05, 20M10; 05A05, 18B40, 18G35, 20B30, 20F55, 20L05, 20M50, 20N02, 68Q17, **AMS members US$95.20**, List US$119, Order code EMSTM/24

# Differential Equations




## Nonlinear Dynamics in Partial Differential Equations

**Shin-Ichiro Ei**, *Hokkaido University, Japan*, **Shuichi Kawashima**, *Kyushu University, Japan*, **Masato Kimura**, *Kanazawa University, Japan*, and **Tetsu Mizumachi**, *Hiroshima University, Japan*, Editors

This volume contains more than fifty peer-reviewed survey and research papers presented at the 4th MSJ-SI International Conference on Nonlinear Dynamics in Partial Differential Equations, held at Kyushu University, Kyushu, Japan, September 12–21, 2011.

Nonlinear partial differential equations describing nonlinear dynamics are indispensable objects in many fields, including technology and social science. This book covers recent mathematical theories and techniques to analyze such nonlinear partial differential equations.

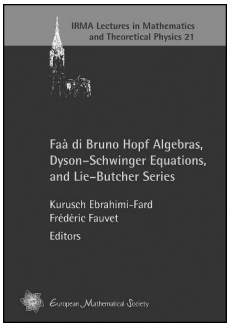
Published for the Mathematical Society of Japan by Kinokuniya, Tokyo, and distributed worldwide, except in Japan, by the AMS.

**Contents:** For the table of contents, go to www.ams.org/bookstore.

**Advanced Studies in Pure Mathematics**, Volume 64

April 2015, 546 pages, Hardcover, ISBN: 978-4-86497-022-8, 2010 *Mathematics Subject Classification:* 35-06; 35-02, 35K55, 35L70, 35L75, 35J60, **AMS members US$101.60**, List US$127, Order code ASPM/64

# Discrete Mathematics and Combinatorics




## Faà di Bruno Hopf Algebras, Dyson–Schwinger Equations, and Lie–Butcher Series

**Kurusch Ebrahimi-Fard**, *Universidad Autónoma de Madrid, Spain*, and **Frédéric Fauvet**, *Université de Strasbourg, France*, Editors

Since the early works of G.-C. Rota and his school, Hopf algebras have been instrumental in algebraic combinatorics. In a seminal 1998 paper, A. Connes and D. Kreimer presented a Hopf algebraic approach to renormalization in perturbative Quantum Field Theory (QFT). This work triggered an abundance of new research on applications of Hopf algebraic techniques in QFT as well as other areas of theoretical physics.

Furthermore, these new developments were complemented by progress made in other domains of applications, such as control theory, dynamical systems, and numerical integration methods. Especially in the latter context, it became clear that J. Butcher's work from the early 1970s was well ahead of its time.

This volume emanated from a conference hosted in June 2011 by IRMA at Strasbourg University in France. Researchers from different scientific communities who share similar techniques and objectives gathered at this meeting to discuss new ideas and results on Faà di Bruno algebras, Dyson–Schwinger equations, and Butcher series. The purpose of this book is to present a coherent set of lectures reflecting the state of the art of research on combinatorial Hopf algebras relevant to high energy physics, control theory, dynamical systems, and numerical integration methods. More specifically, connections between Dyson–Schwinger equations, Faà Bruno algebras, and Butcher series are examined in great detail.

This volume is aimed at researchers and graduate students interested in combinatorial and algebraic aspects of QFT, control theory, dynamical systems and numerical analysis of integration methods. It contains introductory lectures on the various constructions that are emerging and developing in these domains.

*This item will also be of interest to those working in algebra and algebraic geometry.*

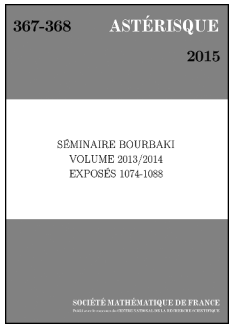
A publication of the European Mathematical Society. Distributed within the Americas by the American Mathematical Society.

**Contents:** For the table of contents, go to www.ams.org/bookstore.

**IRMA Lectures in Mathematics and Theoretical Physics**, Volume 21

June 2015, 466 pages, Softcover, ISBN: 978-3-03719-143-9, 2010 *Mathematics Subject Classification:* 05E15, 06A07, 16T05, 41A58, 58D05, 93C10; 05C05, 81T18, 34A25, 34M25, 47H20, 65L05, 81T15, 81T16, **AMS members US$42.40**, List US$53, Order code EMSILMTP/21

# General Interest




## Séminaire Bourbaki: Volume 2013/2014 Exposés 1074-1088

**A note to readers: This book is in French.**

This 66th volume of the Bourbaki Seminar contains the texts of the fifteen survey lectures done during the year 2013/2014: four lectures on topology and differential geometry, four lectures about partial differential equations, one lecture on the structure of approximate groups, one lecture about functional analysis, one lecture on the algebraic geometry of K3 surfaces, one lecture about the gaps between prime numbers, one lecture on probability theory, and two lectures concerning foundations of mathematics and formal proofs.

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:** For the table of contents, go to www.ams.org/bookstore.

**Astérisque**, Number 367–368

May 2015, 478 pages, Softcover, ISBN: 978-2-85629-804-6, 2010 *Mathematics Subject Classification:* 35A05, 35L71, 37L50, 53C20, 35B35, 35Q20, 45K05, 60J75, 65C05, 82C40, 82C80, 11B30, 03C98, 20N99, 20F67, 57Mxx, 57M25, 57M27, 57R17, 53C42, 49Q20, 14J28, 14C25, 14C20, 14C34, 14G35, 82B44, 82B20, 60K35, 35Q70, 82B40, 82C22, 11N05, 11N13, 11N35, 11N37, 11L05, 11T23, 03B15, 18A15, 03B35, 68T15, 83C05, 53C50, 53C80, 35L72, 05C50, 15A15, 26C10, 46L30, **AMS members US$108**, List US$135, Order code AST/367/368

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*Positions available, items for sale, services available, and more*

## INDIANA

**Notre Dame Institute for Advanced Study (NDIAS)**
**Call for Fellows for 2016–2017**

NDIAS supports research that incorporates applied and theoretical research questions, in all disciplines. The Institute has an open agenda and fosters transformational research that incorporates normative questions and questions of value, especially interdisciplinary inquiry. Fellows receive stipends up to $60,000, subsidized housing, research funding, a faculty office, and multiple opportunities for engagement in an academic community of scientists, artists, and scholars at the University of Notre Dame. All those with promising and appropriate projects, whether distinguished and established or beginning a career, are invited to apply. Application deadline: October 15, 2015. For further information, please see ndias.nd.edu. Direct questions to ndias@nd.edu or 574-631-1305.

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## SOUTH CAROLINA

**UNIVERSITY OF SOUTH CAROLINA**
**Vasil Popov Prize, 2016**
**Call for Nominations**

The Vasil Popov Prize is awarded every three years for outstanding research in fields related to the work of Vasil A. Popov, who is best known for his contributions to Approximation Theory. Candidates must have received their PhD within the previous six years. Nominations, to include a brief description of the relevant work and a vita of the nominee, should be sent to Pencho Petrushev, Chair, Popov Prize Selection Committee, Interdisciplinary Mathematics Institute, University of South Carolina, Columbia, SC 29208; email: popov.prize@gmail.com. The deadline for nominations is November 15, 2015. The Prize will be awarded in May of 2016 at the Fifteenth International Conference in Approximation Theory, in San Antonio, Texas. For further information, visit imi.cas.sc.edu/popov-prize-call-nominations/

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## COMMENTS SOLICITED

**A Solution to the $3x + 1$ Problem**

I continue to believe I have solved this very difficult problem. Reasons why I continue to believe this are given below. However, no journal that I know of is willing to consider the paper, apparently because editors assume that such a difficult problem cannot have been solved by a nonmathematician (my degree is in computer science, and I have been a researcher in the computer industry). Therefore, the only way I can keep the solution before the eyes of the mathematics community is through ads like this.

There have been well over 3,400 visits to the paper, with only six claims of errors. Each of these errors has been fixed, or shown to be the result of misunderstandings of fundamental proofs. Details are in Appendix C of the paper, which is "A Solution to the $3x + 1$ Problem" on occampress.com.

I will welcome reader comments.

*—Peter Schorer*
peteschorer@gmail.com

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**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 publisher reserves the right to reject any advertising not in keeping with the publication's standards. Acceptance shall not be construed as approval of the accuracy or the legality of any advertising.

**The 2015 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.

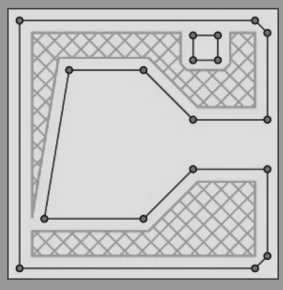
**Upcoming deadlines** for classified advertising are as follows: September 2015 issue–June 29, 2015; October 2015–July 29, 2015; November 2015–August 31, 2015; December 2015—September 29, 2015; January 2016—October 29, 2015; February 2016—December 7, 2016.

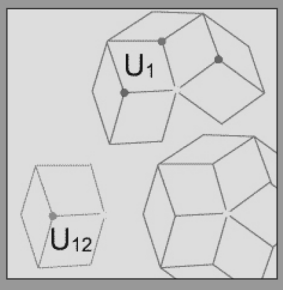
**U.S. laws prohibit** discrimination in employment on the basis of color, age, sex, race, religion, or national origin. "Positions Available" advertisements from institutions outside the US cannot be published unless they are accompanied by a statement that the institution does not discriminate on these grounds whether or not it is subject to US laws. Details and specific wording may be found on page 1373 (vol. 44).

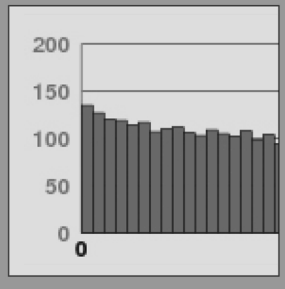
**Situations wanted advertisements** from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-321-4AMS (321-4267) in the US and Canada or 401-455-4084 worldwide for further information.

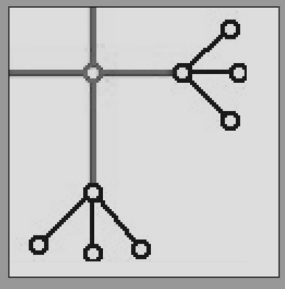
**Submission:** Promotions Department, AMS, P.O. Box 6248, Providence, Rhode Island 02904; or via fax: 401-331-3842; or send email to classads@ams.org. AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 02904. Advertisers will be billed upon publication.

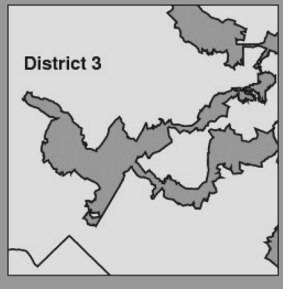
American Mathematical Society

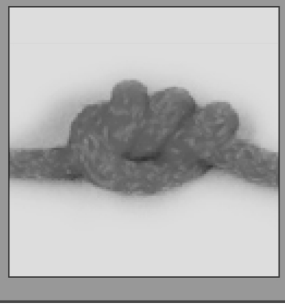






# THE FEATURE COLUMN

*monthly essays on mathematical topics*

Each month, the Feature Column provides an online in-depth look at a mathematical topic. Complete with graphics, links, and references, the columns cover a wide spectrum of mathematics and its applications, often including historical figures and their contributions. The authors—David Austin, Bill Casselman, Joe Malkevitch, and Tony Phillips—share their excitement about developments in mathematics.

Recent essays include:

Why Do We Expect Lots of Twin Primes?

The Topology of Impossible Spaces

Mathematics and Chemistry: Partners in Understanding Our World

Congressional Redistricting and Gerrymandering

Feeling Your Way Around in High Dimensions

The Knots in the Quipu, and in the Friar's Belt

Magical Mathematics - A Tribute to Martin Gardner

How to Make a 3D Print

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# 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 `www.ams.org/meetings/`. Final programs for Sectional Meetings will be archived on the AMS website accessible from the stated URL.

## 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
Issue of *Abstracts*: Volume 36, Issue 4

### Deadlines

For organizers: Expired
For abstracts: August 11, 2015

*The scientific information listed below may be dated. For the latest information, see* `www.ams.org/amsmtgs/sectional.html`.

### Invited Addresses

**Julia Chuzhoy**, Toyota Technological Institute at Chicago, *Title to be announced.*

**Andrew Neitzke**, The University of Texas at Austin, *Title to be announced.*

**Sebastien Roch**, University of Wisconsin-Madison, *Title to be announced.*

**Peter Sarnak**, Princeton University, *Title to be announced* (Erdős Memorial 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* `www.ams.org/cgi-bin/abstracts/abstract.pl`.

*Algebraic Methods Common to Association Schemes, Hopf Algebras, Tensor Categories, Finite Geometry, and Related Areas* (Code: SS 1A), **Harvey Blau**, Northern Illinois University, **Sung Y. Song**, Iowa State University, and **Bangteng Xu**, Eastern Kentucky University.

*Algebraic Statistics and Its Interactions with Combinatorics, Computation, and Network Science* (Code: SS 13A), **Sonja Petrovic**, Illinois Institute of Technology, and **Despina Stasi**, University of Cyprus and Illinois Institute of Technology.

*Algebraic and Combinatorial Invariants of Knots* (Code: SS 17A), **Micah Chrisman**, Monmouth University, **Heather Dye**, McKendree University, **Aaron Kaestner**, North Park University, **Louis Kauffman**, University of Illinois at Chicago, and **Emily Peters**, Loyola University Chicago.

*Analysis of Partial Differential Equations and Fluid Dynamics* (Code: SS 31A), **Mimi Dai**, University of Illinois at Chicago, **Vera Mikyoung Hur**, University of Illinois at Urbana-Champaign, and **Yao Yao**, University of Wisconsin-Madison.

*Automorphic Forms and Representations* (Code: SS 21A), **Moshe Adrian**, University of Toronto, and **Shuichiro Takeda** and **Aaron Wood**, University of Missouri-Columbia.

*Automorphisms of Riemann Surfaces and Related Topics* (Code: SS 11A), **S. Allen Broughton**, Rose-Hulman Institute of Technology, **Peter Turbek**, Purdue University Calumet, **Anthony Weaver**, Bronx Community College, the City University of New York, and **Aaron Wootton**, University of Portland.

*Coding Theory and Its Applications* (Code: SS 24A), **W. Cary Huffman**, Loyola University Chicago.

*Cohomology of Algebras and Deformation Theory* (Code: SS 16A), **Anthony Giaquinto**, Loyola University Chicago, **Mihai D. Staic**, Bowling Green State University, and **Alin Stancu**, Columbus State University.

*Combinatorial and Computational Algebra* (Code: SS 4A), **David Cook II**, Eastern Illinois University, and **Sonja Mapes**, University of Notre Dame.

*Combinatorial and Geometric Representation Theory* (Code: SS 9A), **Ben Salisbury**, Central Michigan University, and **Peter Tingley**, Loyola University Chicago.

*Commutative Algebra* (Code: SS 27A), **Youngsu Kim** and **Paolo Mantero**, University of California, Riverside, and **Jonathan Montano**, Purdue University.

*Computability Theory and Applications* (Code: SS 19A), **Denis Hirschfeldt**, University of Chicago, and **Steffen Lempp**, University of Wisconsin-Madison.

*Enumerative Algebraic and Geometric Combinatorics* (Code: SS 5A), **Kyle Petersen**, DePaul University, and **Steven Klee**, Seattle University.

*Enumerative Combinatorics and Graph Theoretic Applications* (Code: SS 12A), **Adam Goyt**, Minnesota State University, and **Lara Pudwell**, Valparaiso University.

*Ergodic and Symbolic Actions of Amenable Groups* (Code: SS 39A), **Ayşe Şahin** and **Ilie Ugarcovici**, DePaul University.

*Frontiers in Computational Mathematics* (Code: SS 25A), **Sou-Cheng (Terrya) Choi**, NORC at the University of Chicago, and Illinois Institute of Technology.

*Generalized Derivatives* (Code: SS 36A), **J. Marshall Ash**, DePaul University, and **Paul Musial**, Chicago State University.

*Geometric Partial Differential Equations* (Code: SS 26A), **Morgan Sherman**, California Polytechnic State University, and **Valentino Tosatti** and **Ben Weinkove**, Northwestern University.

*Geometric Perspectives in Knot Theory* (Code: SS 14A), **David Krcatovich** and **Allison Moore**, Rice University.

*Graduate Student Perspectives on Undergraduate Research* (Code: SS 32A), **Mindy Capaldi** and **Zsuzsanna Szaniszlo**, Valparaiso University.

*Groups, Rings, Group Rings, and Hopf Algebras (Celebrating the 75th birthday of Donald S. Passman)* (Code: SS 2A), **Jeffrey Bergen**, **Stefan Catoiu**, and **William Chin**, DePaul University.

*History of Mathematics* (Code: SS 10A), **Steven Jordan**, Loyola University Chicago.

*Hopf Algebraic Combinatorics* (Code: SS 6A), **Marcelo Aguiar**, Cornell University, and **Aaron Lauve**, Loyola University Chicago.

*K-loops, Neardomains, Loops, and Nonassociative Division Algebras* (Code: SS 38A), **Alper Bulut**, American University of the Middle East, **C. E. Ealy Jr.**, Western Michigan University, **Hubert Kiechle**, University of Hamburg, **Benjamin Phillips**, University of Michigan Dearborn, and **J. D. Phillips**, Northern Michigan University.

*Mathematical Analysis and Computation of Nematic Liquid Crystals* (Code: SS 20A), **Patricia Bauman**, **Daniel Phillips**, and **Changyou Wang**, Purdue University.

*Mathematics of Evolution* (Code: SS 3A), **Ruth Davidson**, University of Illinois Urbana-Champaign, and **Ruriko Yoshida**, University of Kentucky.

*Metric Spaces: Geometry, Group Theory, and Dynamics* (Code: SS 18A), **Tullia Dymarz**, University of Wisconsin-Madison, and **Anton Lukyanenko**, University of Michigan.

*Model Theory* (Code: SS 15A), **Uri Andrews**, University of Wisconsin-Madison, **Isaac Goldbring**, University of Illinois at Chicago, and **Maryanthe Malliaris**, University of Chicago.

*Nonlinear PDEs and Calculus of Variations* (Code: SS 22A), **Emmanuel Barron**, **Marian Bocea**, and **Robert Jensen**, Loyola University Chicago.

*Nonlocal Diffusions* (Code: SS 30A), **Jinqiao Duan**, **Xiaofan Li**, and **Xiaoxia Xie**, Illinois Institute of Technology.

*Probability Theory* (Code: SS 29A), **Antonio Auffinger**, Northwestern University, **Jian Ding**, University of Chicago, and **Sebastien Roch**, University of Wisconsin-Madison.

*Recent Advances in Non-Commutative Analysis* (Code: SS 37A), **Hari Bercovici**, Indiana University, and **John Williams**, Universität des Saarlandes.

*Recent Developments in Graph and Matroid Theory* (Code: SS 23A), **Sergei Bezrukov**, University of Wisconsin-Superior, **Dalibor Froncek**, University of Minnesota Duluth, and **Xiaofeng Gu** and **Steven Rosenberg**, University of Wisconsin-Superior.

*Recent Developments in the Theory and Applications of Reaction Network Models* (Code: SS 28A), **Carsten Conradi**, Max Planck Institute, and **Casian Pantea**, West Virginia University.

*Singularities in Algebra, Geometry and Topology* (Code: SS 33A), **Manuel Gonzalez Villa** and **Laurentiu Maxim**, University of Wisconsin-Madison.

*Stochastic Analysis With Applications to Quantitative Finance* (Code: SS 35A), **Igor Cialenco** and **Ruoting Gong**, Illinois Institute of Technology.

*The Langlands Program and Related Topics* (Code: SS 34A), **Andrei Jorza**, University of Notre Dame, and **Martin Luu**, University of Illinois at Urbana-Champaign.

*Topics in Graph Theory, Hypergraphs and Set Systems* (Code: SS 8A), **John Engbers**, Marquette University, and **David Galvin**, University of Notre Dame.

*Variational Analysis, Optimization, and Control (Dedicated to Terry Rockafellar on the occasion of his 80th birthday)* (Code: SS 7A), **Rafal Goebel**, Loyola University Chicago.

# 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
Issue of *Abstracts*: Volume 36, Issue 3

## Deadlines

For organizers: Expired
For abstracts: August 25, 2015

*The scientific information listed below may be dated. For the latest information, see* `www.ams.org/amsmtgs/sectional.html`.

## Invited Addresses

**Mark van Hoeij**, Florida State University, *Solving problems with the LLL algorithm.*

**Vaughan Jones**, Vanderbilt University, *Are all subfactors related to quantum field theory?.*

**Mette Olufsen**, North Carolina State 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* `www.ams.org/cgi-bin/abstracts/abstract.pl`.

*Advances in Operator Theory and Applications, in memory of James Jamison* (Code: SS 5A), **Fernanda Botelho**, University of Memphis, and **T.S.S.R.K. Rao**, Indian Statistical Institute Bangalore.

*Analysis of Differential and Integral Equations* (Code: SS 18A), **D.P. Dwiggins** and **T. Hagen**, University of Memphis.

*Banach Spaces and Applications* (Code: SS 4A), **Anna Kaminska**, **Peikee Lin**, and **Bentuo Zheng**, University of Memphis.

*Cahn-Hilliard and Related Equations and Applications.* (Code: SS 11A), **Giséle Ruiz Goldstein**, University of Memphis, and **Alain Miranville**, Université de Poitiers.

*Computational Analysis* (Code: SS 1A), **George Anastassiou**, University of Memphis.

*Control and Inverse Problems for Partial Differential Equations* (Code: SS 6A), **Matthias Eller**, Georgetown University, **Shitao Liu**, Clemson University, and **Roberto Triggiani**, University of Memphis.

*Difference Equations and Applications* (Code: SS 12A), **Michael A. Radin**, Rochester Institute of Technology, and **Youssef Raffoul**, University of Dayton.

*Ergodic Theory* (Code: SS 8A), **James T. Campbell** and **Mate Wierdl**, University of Memphis.

*Evolution Equations and Partial Differential Equations* (Code: SS 19A), **Jerome A. Goldstein**, University of Memphis, **Rainer Nagel**, Universitaet Tuebingen, and **Guillermo Reyes**, University of Southern California.

*Extremal Graph Theory (In memory of Ralph Faudree)* (Code: SS 3A), **Paul Balister**, University of Memphis, **Béla Bollobás**, University of Cambridge UK, and University of Memphis, and **Vladimir Nikiforov**, University of Memphis.

*Fractal Geometry and Dynamical Systems* (Code: SS 2A), **Mrinal Kanti Roychowdhury**, University of Texas-Pan American.

*Probabilistic Combinatorics* (Code: SS 17A), **Paul Balister**, University of Memphis, and **Béla Bollobás**, University of Cambridge UK, and University of Memphis.

*Recent Advances in Commutative Algebra* (Code: SS 13A), **Sandra Spiroff**, University of Mississippi, and **Lance Miller**, University of Arkansas.

*Recent Developments in the Statistical Analysis of Large Clustered Data* (Code: SS 10A), **E. Olusegun George**, University of Memphis.

*Spectra of Graphs and Hypergraphs.* (Code: SS 9A), **Vladimir Nikiforov**, University of Memphis.

*Stabilization, Control, and Analysis of Evolutionary Partial Differential Equations* (Code: SS 7A), **George Avalos**, University of Nebraska Lincoln, **Scott Hansen**, Iowa State University, and **Justin Webster**, North Carolina State University & College of Charleston.

*The Analysis, Geometry, and Topology of Groupoids* (Code: SS 15A), **Emily Proctor**, Middlebury College, and **Christopher Seaton**, Rhodes College.

*Topological Combinatorics* (Code: SS 14A), **Eric Gottlieb**, Rhodes College, and **Russ Woodroofe**, Mississippi State University.

*von Neumann Algebras* (Code: SS 16A), **Vaughan Jones**, Vanderbilt University, and **David Penneys**, University of California Los Angeles.

## Accommodations

Participants should make their own arrangements directly with the hotel of their choice. Special discounted rates were negotiated with the hotels listed below. Rates quoted do not include a room tax of 15.95%. **Participants should use the group code for each of the hotels** to receive the discounted rates. The AMS is not responsible for rate changes or for the quality of the accommodations. **Hotels have varying cancellation and early checkout penalties; be sure to ask for details.** Additional hotels may be listed on the AMS sectional meeting website beginning in August.

**Fogelman Executive Conference Center** (across the street from campus), 330 Innovation Dr., Memphis, TN 38152; 901-678-5410 (phone); `bf.memphis.edu/fecc/`. Rates are US$90 for one queen-bedded room; includes free wireless Internet and coffeemaker. Please cite the **American Mathematical Society rate** when making your reservation. Guests may use the Holiday Inn fitness room next door. There is free parking and free shuttle service from and to the airport between 7:00 a.m. and 10:00 p.m.; be sure to ask when you make your reservation. **Deadline for reservations is September 11, 2015.**

**Holiday Inn-University of Memphis** (across the street from campus), 3700 Central Ave., Memphis, TN 38111, online at www.holidayinn.com/mem-uofm or by phone at 1-901-678-8200 **(cite our group code MAT).** This is an all-suites hotel. Rates are US$120/room with a sleeper sofa. All two-room suites have refrigerators and complimentary Internet. The on-site restaurant, Medallion, is open for breakfast, lunch (a la carte or full buffet), and dinner, and features a full service lounge with a bar. Amenities include a fitness room on site, or use the fitness facilities of the University of Memphis Health Center. There is free parking and free shuttle service from and to the airport between 7:00 a.m. and 10:00 p.m.; be sure to ask when you make your reservation. **Deadline for reservations is September 11, 2015.**

## Registration and Meeting Information

### Advance Registration

Advance registration for this meeting will open on **August 1, 2015**. Advance registration fees will be US$56 for AMS members, US$78 for nonmembers, and US$5 for students, unemployed mathematicians, and emeritus members.

### Onsite Information and Registration

The Registration Desk and the AMS Book Exhibit will be located in the lobby of the Psychology Auditorium where the Invited Addresses will take place. Special Sessions and Sessions for Contributed Papers will be held in Dunn Hall where the Department of Mathematical Sciences is located. A campus map can be viewed at www.umwa.memphis.edu/campusmap/index.php. The Registration Desk will be open on Saturday, October 17, 7:30 a.m.–4:00 p.m. and Sunday, October 18, 8:00 a.m.–noon. Fees on site will be the same as those for advance registration listed above and are payable via cash, check, or credit card.

## Other Activities

**Book Sales:** Stop by the onsite AMS bookstore to review the newest publications and take advantage of exhibit discounts and free shipping on all onsite orders! AMS members receive 40% off list price. Nonmembers receive a 25% discount. Not a member? Ask a representative about the benefits of AMS membership. Complimentary coffee will be served courtesy of AMS Membership Services.

**AMS Editorial Activity:** An acquisitions editor from the AMS book program will be present to speak with prospective authors. If you have a book project that you would like to discuss with the AMS, please stop by the book exhibit.

## Local Information and Maps

This meeting will take place on the main campus of the University of Memphis in the Psychology Auditorium (Invited Addresses, meeting registration and the AMS book exhibit), as well as Dunn Hall (home of the Department of Mathematics and the location for Special Sessions and Sessions for Contributed Papers). A campus map can be viewed at umwa.memphis.edu/campusmap/index.php. Information about the University of Memphis Department of Mathematical Sciences can be found on their website at www.memphis.edu/msci/. Please watch the AMS website at www.ams.org/meetings/sectional/sectional.html for additional information about this meeting. Please visit the University of Memphis website at www.memphis.edu for additional information about the campus.

## Food Service on Campus

The Tiger Den in Jones Hall offers an "all you can eat" option with grilled favorites, authentic and ethnic cuisines, homemade entrees, pizza, pasta, sandwiches, wraps, vegetarian entrees, salad bar, soups, and fresh baked cookies, cakes, and ice cream; US$6.50 for breakfast and US $7.75 for lunch and dinner (both plus tax). The University Center has a food court with a variety of food venues: Chick-fil-A, Bistro Nineteen Twelve, Topio's (pizza), Miso, Union Express, and Taco Bell.

## Parking

The large parking lot accessible from Central Ave. offers free parking for meeting participants. It is adjacent to the parking lot that services the Fogelman Executive Conference Center and the Holiday Inn.

## Travel

The meeting will be held at the main campus of the University of Memphis, 3720 Alumni Ave., Memphis, TN 38152.

**By Air:** The closest airport to the university is Memphis International Airport (MEM), 2491 Winchester Rd., Memphis, TN 38116; (901) 922-8000; www.mscaa.com. It is about 7.5 miles from the airport to campus.

See the services provided at the airport at www.mscaa.com/shop/amenities.

**Taxis:** Taxi service is available from the Memphis airport for approximately US$25 to the listed hotels and the University.

**Car Rental:** Rental cars are available through a number of agencies at the airport. Please visit the airport website for information on rental car companies in Memphis.

## Driving Directions

**From the airport (rental car dealerships):** Turn right onto Democrat Rd. Take the Plough Blvd./Airways North exit. Take the I-240 exit to Nashville (keep right). Take the Getwell North exit (exit 20B). Follow Getwell north until it ends at Park Ave. Turn right/east onto Park Ave. Drive one block and turn left/north onto Goodlett St. Cross the railroad tracks to Central Ave. Turn left/west on Central. Turn left/south on Patterson.

**From the East on I-40**: Follow the Sam Cooper Blvd. signs (it will split off of I-40 to the left). Take the Highland St. exit and go left/south onto Highland. After four lights, turn left/east on Central/ Turn right/south on Patterson.

**From the West on I-40:** Take the Riverside Dr. exit and go right/south onto Riverside Dr. Turn left/east on Union Ave. (Union will change names to Walnut Grove.) Turn right/south on Highland. Turn left/east on Central. Turn right/south on Patterson

**From the North on I-55**: Follow I-40 signs; go east on I-40. Take the Riverside Dr. exit and go right/south onto Riverside Dr. Turn left/east on Union Ave. (Union will change names to Walnut Grove.) Turn right/south on Highland. Turn left/east on Central. Turn right/south on Patterson.

**From the South on I-55**: Take the I-240 exit to Nashville (keep right). Take the Getwell North exit (exit 20B). Follow Getwell north until it ends at Park Ave. Turn right/east onto Park Ave. Drive one block and turn left/north onto Goodlett St. Cross the railroad tracks to Central Ave. Turn left/west on Central. Turn left/south on Patterson.

**From the North on Hwy. 51**: Just south of Millington, turn left/east onto Paul Barret Pkwy. (also TN 385). Turn right/west onto I-40. Follow the Sam Cooper Blvd. signs (it will split off of I-40 to the left). Take the Highland St. exit and go left/south onto Highland. After four lights, turn left/east on Central. Turn right/south on Patterson.

**From the South on Hwy. 78**: Take the Perkins St. exit and go right/north onto Perkins. Turn left/west on Park Ave. Turn right/north on Goodlett. Turn left/west on Central.

### Special Needs

It is the goal of the AMS to ensure that its conferences are accessible to all, regardless of disability. The AMS will strive, unless it is not practicable, to choose venues that are fully accessible to the physically handicapped.

If special needs accommodations are necessary in order for you to participate in an AMS Sectional Meeting, please communicate those needs, in advance, to the AMS Meetings Department by:

- Registering early for the meeting

-Checking the appropriate box on the registration form, *and*

- Sending an email request to the AMS Meetings Department at mmsb@ams.org or meet@ams.org.

### Weather

The month of October is one of the best times of the year to visit Memphis. Daytime temperatures are in the mid 70s and evening temperatures are in the mid 50s. October is known as the driest month of the year; however, conditions can change rapidly. Visitors should check weather forecasts in advance of their arrival.

### Information for International Participants

Visa regulations are continually changing for travel to the United States. Visa applications may take from three to four months to process and require a personal interview, as well as specific personal information. International participants should view the important information about traveling to the U.S. found at sites.nationalacademies.org/pga/biso/visas/ and travel.state.gov/visa/visa_1750.html. If you need a preliminary conference invitation in order to secure a visa, please send your request to aba@ams.org.

If you discover you do need a visa, the National Academies website (see above) provides these tips for successful visa applications:

* Visa applicants are expected to provide evidence that they are intending to return to their country of residence. Therefore, applicants should provide proof of "binding" or sufficient ties to their home country or permanent residence abroad. This may include documentation of the following:

- family ties in home country or country of legal permanent residence

- property ownership

- bank accounts

- employment contract or statement from employer stating that the position will continue when the employee returns;

* Visa applications are more likely to be successful if done in a visitor's home country than in a third country;

* Applicants should present their entire trip itinerary, including travel to any countries other than the United States, at the time of their visa application;

* Include a letter of invitation from the meeting organizer or the U.S. host, specifying the subject, location and dates of the activity, and how travel and local expenses will be covered;

* If travel plans will depend on early approval of the visa application, specify this at the time of the application;

* Provide proof of professional scientific and/or educational status (students should provide a university transcript).

This list is not to be considered complete. Please visit the websites above for the most up-to-date information.

### Social Networking

Attendees and speakers are encouraged to tweet about the meeting using the hashtag #AMSmtg.

# 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*: October 2015
Issue of *Abstracts*: Volume 36, Issue 4

### Deadlines

For organizers: Expired
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, *Refined Chern-Simons Index and Knot Homology*.

**John Lott**, University of California - Berkeley, *3D Ricci flow since Perelman*.

**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* www.ams.org/cgi-bin/abstracts/abstract.pl.

*Algebraic and Combinatorial Structures in Knot Theory* (Code: SS 9A), **Allison Henrich**, Seattle University, **Aaron M. Kaestner**, North Park University, **Sam Nelson**, Claremont McKenna College, and **Matt Rathbun**, California State University, Fullerton.

*Analysis on Metric Spaces (In honor of Fred Gehring on the occasion of his 90th birthday)* (Code: SS 23A), **Zair Ibragimov**, California State University, Fullerton.

*Applied Mathematics in Industry: In Memory of Professor John G. Pierce (1942-2015)* (Code: SS 8A), **Charles H. Lee** and **Angel R. Pineda**, California State University, Fullerton.

*Fixed Point Theory and Applications* (Code: SS 10A), **Clement B. Ampadu**, **Talat Nazir**, Malardalen University, and **Xavier A. Udo-Utun**, University of Uyo.

*Geometric Analysis* (Code: SS 1A), **John Lott**, University of California, Berkeley, and **Aaron Naber**, Northwestern University.

*History and Philosophy of Mathematics* (Code: SS 15A), **Jim Tattersall**, Providence College, and **Shawn McMurran**, California State University, San Bernardino.

*Homological Methods in Commutative Algebra* (Code: SS 22A), **Amanda Croll**, Concordia University, Irvine, and **Jack Jeffries**, University of Michigan.

*Humanistic Mathematics* (Code: SS 20A), **Mark Huber**, Claremont McKenna College, and **Gizem Karaali**, Pomona College.

*Mathematical Techniques in Quantum Theories and Quantum Finance, with applications* (Code: SS 11A), **Alfonso F. Agnew**, California State University at Fullerton, and **David Carfi**, University of Messina, Italy.

*Mathematical/Statistical modeling and its applications to science and engineering* (Code: SS 19A), **Kanadpriya Basu**, University of Texas at El Paso.

*Mathematicians and Outreach Programs* (Code: SS 2A), **Olga Radko**, University of California Los Angeles, and **Bodgan D. Suceava**, California State University, Fullerton.

*Nonlinear Conservation Laws and Applications* (Code: SS 6A), **Matthias Youngs**, Indiana Unversity-Purdue University Columbus, **Cheng Yu**, University of Texas at Austin, and **Kun Zhao**, Tulane University.

*Recent Advances in Computational and Mathematical Biology* (Code: SS 16A), **Fengzhu Sun**, University of Southern California, and **Jianjun Paul Tian** and **Mary Ballyk**, New Mexico State University.

*Recent Advances in Finite Groups and their Representations* (Code: SS 5A), **Adam Glesser**, California State University, Fullerton, and **Mandi Schaeffer Fry**, Metropolitan State University of Denver.

*Recent Advances in Number Theory* (Code: SS 18A), **Christopher Lyons**, California State University, Fullerton, and **Karl Rubin** and **Alice Silverberg**, University of California, Irvine.

*Recent Developments in Nonlinear Partial Differential Equations* (Code: SS 12A), **Changyou Wang**, Purdue University, and **Yifeng Yu**, University of California at Irvine.

*Recent results in Operator Theory and Operator Algebras* (Code: SS 14A), **Asuman G. Aksoy**, Claremont McKenna College, **Don Hadwin**, University of New Hampshire, and **Hassan Yousefi**, California State University, Fullerton.

*Research in Mathematics by Early Career Graduate Students* (Code: SS 7A), **Tamas Forgacs**, **Carmen Caprau**, and **Oscar Vega**, California State University, Fresno.

*Spatial Graphs* (Code: SS 13A), **Erica Flapan**, Pomona College, **Thomas Mattman**, California State University, Chico, **Blake Mellor**, Loyola Marymount University, **Ramin Naimi**, Occidental College, and **Ryo Nikkuni**, Tokyo Women's Christian University.

*Spatio-Temporal Modeling of Neuronal Data* (Code: SS 6A), **Reza Ramezan** and **Sam Behseta**, California State University, Fullerton.

*Spectral Asymptotics of Large Matrices* (Code: SS 3A), **Alain Bourget** and **Tyler McMillen**, California State University, Fullerton.

*Spectral Theory of Ergodic Schrödinger Operators and related models* (Code: SS 21A), **S. Jitomirskaya**, University of California, Irvine, and **Christoph Marx**, Oberlin College.

*Stochastic modeling and statistical inference* (Code: SS 17A), **Qidi Peng**, Claremont Graduate University.

*Strategies of Training Pre-Service Teachers* (Code: SS 4A), **Margaret Kidd**, **Cherie Ichinose**, **David Pagni**, and **Bogdan D. Suceava**, California State University, Fullerton.

## Session for Contributed Talks

There also will be a session for 10-minute contributed talks. Please see the abstracts submission form at www.ams.org/cgi-bin/abstracts/abstract.pl. **The deadline for all abstracts submissions is September 1, 2015.**

## Accommodations

Participants should make their own arrangements directly with the hotel of their choice. Special discounted rates were negotiated with the hotels listed below. Other hotels for this meeting may be added to the AMS website; check www.ams.org/meetings/sectional/sectional.html for more information. **Rates quoted do not include hotel tax of 10%.** Participants must state that they are with the **American Mathematical Society (AMS) Math Meeting at the California State University, Fullerton** to receive the discounted rates. The AMS is not responsible for rate changes or for the quality of the accommodations. **Hotels have varying cancellation and early checkout penalties; be sure to ask for details when you make your reservation.**

**Fullerton Marriott at California State University**, 2701 East Nutwood Ave., Fullerton, CA 92831; 714-579-7800 (phone); 714-738-0288 (fax); www.marriott.com/hotels/travel/laxfl-fullerton-marriott-at-california-state-university/. Across the street from the meeting site. Rates are US$129 + tax per room, per night for a room with 2 full size or 1 king bed. Amenities include complimentary guest room Internet, free overnight self-parking, 24 hour fitness center, and an outdoor pool. There is a restaurant and a bar, Ha' Penny Pub, on site. This hotel is a nonsmoking property. Check-in time is 4:00 p.m. and check out time is 12:00 p.m. **The deadline for reservations at the above rate is September 25, 2015.**

**Holiday Inn Hotel & Suites Anaheim - Fullerton**, 2932 Nutwood Ave., Fullerton, CA 92831; 714-579-7400 (phone); 714-528-7945 (fax); www.fullertonhi.com. It is about .3 miles walk to the meeting site. Rates are US$119 + tax per room, per night for a room with 1 king bed with a coffee maker, refrigerator, and a desk. Amenities include complimentary guest room Internet, free overnight self-parking, fitness center, and an outdoor pool. There is a restaurant and a bar, 57 Bar & Grill, on site. This hotel is a nonsmoking property. Check in time is 3:00 p.m. and check out time is 12:00 p.m. **The deadline for reservations at the above rate is October 2, 2015.**

**Residence Inn Anaheim Placentia/Fullerton**, 700 W Kimberly Ave., Placentia, CA 92870; 714-996-0555 (phone); 1-714-993-1043 (fax); www.marriott.com/hotels/travel/snapl-residence-inn-anaheim-placentia-fullerton/. It is about 1.4 miles from the meeting site. Rates are US$125 + tax per night for a room with 1 king bed with fully equipped kitchen, a pull-out sofa bed, and a desk. Amenities include complimentary breakfast, parking & wireless Internet; fitness center, and an outdoor pool. This hotel is a nonsmoking property. Check in time is 4:00 p.m. and check out time is 12:00 p.m. **The deadline for reservations is September 30, 2015**.

**Quality Inn Placentia - Anaheim**, 710 W Kimberly Ave., Placentia, CA 92870; 714-996-4410 (phone); www.qualityinnplacentiaca.com. It is about 1.4 miles from the meeting site. Rates are US$84 + tax per night for a room with 2 full size or 1 king bed with fully equipped kitchen, and a desk. Amenities include complimentary breakfast, parking & wireless Internet; fitness center, business center, and an outdoor pool. This hotel is a nonsmoking property. Check in time is 3:00 p.m. and check out time is 11:00 a.m. **The deadline for reservations is October 2, 2015**.

**The Hotel Fullerton**, 1500 S. Raymond Ave., Fullerton CA, 92831; 714-635-9000 (phone), 714-520-4622 (fax). booking.ihotelier.com/istay/istay.jsp?groupID=1442058&hotelID=77586. It is about a 3 mile walk to the meeting site. Rooms are US$105 + tax per night for a room with 2 full size or 1 king bed with a coffee maker, refrigerator, and a desk. Amenities include complimentary guest room Internet, free overnight self-parking, a 24 hour fitness center, a 24 hour business center, and an outdoor pool. There is a restaurant, RED, and bar, Griswold Bar & Grill on site, as well as room service. This hotel is a nonsmoking property. Check in time is 3:00 p.m. and check out time is 11:00 a.m. **The deadline for reservations is October 2, 2015.**

## Food Services

**Carl's Jr.**, 800 N State College Blvd., 657-278-3880, www.carlsjr.com. Fast-food chain known for its variety of piled-high burgers & meal combos, plus shakes. Open Saturday, 10:00 am – 2:00 pm, and Sunday, 12:00 pm – 12:00 am.

**Ha'penny Pub**, 2701 Nutwood Ave., 714-738-7800. Treat yourself, colleagues or friends to a delicious breakfast, lunch or dinner at this Fullerton pub that offers a casual atmosphere and serves up Irish-themed cuisine and drinks. Open Saturday and Sunday, 6:00 am – 10:00 pm.

**The Habit Burger Grill**, 2720 Nutwood Ave., 714-871-9116, www.habitburger.com. Charbroiled burgers star at this fast-food chain also offering deli-type sandwiches, salads & fries. Open Saturday, 10:30 am – 9:00 pm, and Sunday, 11:00 am – 8:00 pm.

**Which Wich**, 2720 Nutwood Ave., 714-869-3820, www.whichwich.com. Modern, casual chain known for design-your-own sandwiches & varied bread options. Open Saturday and Sunday, 6:00 am – 10:00 pm.

**Flame Broiler**, 2720 Nutwood Ave., 714-526-2720, www.flamebroilerusa.com. Simple fast-food chain preparing Korean-style meat & rice bowls with no dairy, trans-fat or frying. Open Saturday, 11:00 am – 9:00 pm, and Sunday, 11:00 am – 8:00 pm.

**Maru Sushi**, 2931 Nutwood Ave., 714-528-8111. Best Japanese cuisine in town. Come discover a new way to enjoy sushi...and more. Our state-of-art Japanese menu is exquisite. Open Saturday and Sunday, 11:30 am – 10:00 pm.

## Registration and Meeting Information

### Advance Registration

Advance registration for this meeting will open on **August 3, 2015**. Fees will be US$56 for AMS members, US$78 for nonmembers, and US$5 for students, unemployed mathematicians, and emeritus members.

### Onsite Information and Registration

Registration, the book exhibit, and Invited Addresses will be located in the Steven G. Mihaylo Hall. The registration desk will be open on Saturday, October 24, 7:30 a.m.–4:00 p.m. and Sunday, October 25, 8:00 a.m.–noon. Fees are the same as advance registration and will be payable on site via cash, check, or credit card.

Special Sessions will take place in Langsdorf Hall, S.G. Mihaylo Hall, and University Hall.

## Special Needs

It is the goal of the AMS to ensure that its conferences are accessible to all, regardless of disability. The AMS shall strive, unless it is not practicable, to choose venues that are fully accessible to the physically handicapped.

If special needs accommodations are necessary in order for you to participate in an AMS Sectional Meeting, please

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**AMS Editorial Activity:** An acquisitions editor from the AMS book program will be present to speak with prospective authors. If you have a book project that you wish to discuss with the AMS, please stop by the book exhibit.

### Parking

Parking is available on site. Please see the details at the Parking and Transportation Services website at asi.fullerton.edu/directionsandmaps.asp.

### Travel

**Airport:** You should plan to fly into John Wayne Airport (SNA); see www.ocair.com for details. Taxis are available outside the baggage claim area. Some hotels provide free shuttle services; please check when making your reservations. An alternative airport is Los Angeles International Airport (LAX), which is 37.5 miles away from campus.

**Car Rental**: Hertz is the official car rental company for the meeting. To make a reservation accessing our special meeting rates online at www.hertz.com, click on the box "I have a discount", and type in our convention number (CV): 04N30005. You can also call Hertz directly at 800-654-2240 (US and Canada) or 1-405-749-4434 (other countries). At the time of reservation, the meeting rates will be automatically compared to other Hertz rates and you will be quoted the best comparable rate available.

**Driving to CSU**: Please use your favorite travel website for the best advice on driving to campus. The main address of the campus is 800 N. State College Blvd., Fullerton, CA 92831-3599. The address for Mihaylo Hall is 2550 Nutwood Avenue, Fullerton, CA 92831. Please see https://police.fullerton.edu/documents/PrintableCampusMap.pdf for a helpful map.

### Weather

During the month of October the average high temperature is in the high 70s, the average low temperature is in the mid-50s and there is very little rainfall.

### Information for International Participants

Visa regulations are continually changing for travel to the United States. Visa applications may take from three to four months to process and require a personal interview, as well as specific personal information. International participants should view the important information about traveling to the US found at sites.nationalacademies.org/pga/biso/visas/ and travel.state.gov/visa/visa_1750.html. If you need a preliminary conference invitation in order to secure a visa, please send your request to aba@ams.org.

If you discover you do need a visa, the National Academies website (see above) provides these tips for successful visa applications:

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- property ownership
- bank accounts
- employment contract or statement from employer stating that the position will continue when the employee returns;

* Visa applications are more likely to be successful if done in a visitor's home country than in a third country;

* Applicants should present their entire trip itinerary, including travel to any countries other than the United States, at the time of their visa application;

* Include a letter of invitation from the meeting organizer or the US host, specifying the subject, location and dates of the activity, and how travel and local expenses will be covered;

* If travel plans will depend on early approval of the visa application, specify this at the time of the application;

* Provide proof of professional scientific and/or educational status (students should provide a university transcript).

This list is not to be considered complete. Please visit the websites above for the most up-to-date information.

### Social Networking

Participants and speakers are encouraged to tweet about the meeting using the hashtag #AMSmtg.

# 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: Expired
For abstracts: September 22, 2015

*The scientific information listed below may be dated. For the latest information, see* www.ams.org/amsmtgs/sectional.html.

### Invited Addresses

**Lee Mosher**, Rutgers University, *Title to be announced.*

**Jill Pipher**, Brown University, *Title to be announced.*

**David Vogan**, Massachusetts Institute of Technology, *Title to be announced.*

**Wei Zhang**, Columbia 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* www.ams.org/cgi-bin/abstracts/abstract.pl.

*Advances in Valuation Theory* (Code: SS 6A), **Samar El Hitti**, New York City College of Technology, City University of New York, **Franz-Viktor Kuhlmann**, University of Saskatchewan, and **Hans Schoutens**, New York City College of Technology, City University of New York.

*Algebraic Geometry and Combinatorics* (Code: SS 9A), **Elizabeth Drellich**, University of North Texas, **Erik Insko**, Florida Gulf Coast University, **Aba Mbirika**, University of Wisconsin-Eau Claire, and **Heather Russell**, Washington College.

*Applications of CAT(0) Cube Complexes* (Code: SS 1A), **Sean Cleary**, City College of New York and the City University of New York Graduate Center, and **Megan Owen**, Lehman College of the City University of New York.

*Aspects of Minimal Surfaces in Riemannian Manifolds* (Code: SS 4A), **Zheng Huang** and **Marcello Lucia**, City University of New York, Staten Island and Graduate Center.

*Aspects of Resolutions and Syzygies in Commutative Algebra* (Code: SS 12A), **Courtney Gibbons**, Hamilton College, and **Denise Rangel Tracy**, Syracuse University.

*Commutative Algebra* (Code: SS 2A), **Laura Ghezzi**, New York City College of Technology, City University of New York, and **Jooyoun Hong**, Southern Connecticut State University.

*Difference equations and applications* (Code: SS 5A), **Manos Drymonis**, Providence College, **Evelina Lapierre**, Johnson and Wales University, and **Michael Radin**, Rochester Institute of Technology.

*Geometric Analysis* (Code: SS 22A), **Paul Feehan**, **Manos Maridakis**, and **Natasa Sesum**, Rutgers University.

*Geometric Topology: A Celebration of Jim West's 70th Birthday* (Code: SS 3A), **Alexandre Dranishnikov**, University of Florida, **Steve Ferry**, Rutgers University, and **Boris Goldfarb**, State University of New York at Albany.

*Geometry and Combinatorics of Polytopes* (Code: SS 19A), **Egon Schulte**, Northeastern University, and **Asia Ivić Weiss**, York University.

*Geometry of groups, surfaces and 3-manifolds* (Code: SS 14A), **Abhijit Champanerkar**, College of Staten Island and The Graduate Center, City University of New York, **Feng Luo**, Rutgers University, and **Joseph Maher**, College of Staten Island and The Graduate Center, City University of New York.

*Invariants of knots, links and 3 manifolds* (Code: SS 16A), **Ilya Kofman**, College of Staten Island and The Graduate Center, City University of New York, and **Adam Lowrance**, Vassar College.

*Modern Schubert calculus* (Code: SS 17A), **Anders Buch** and **Chris Woodward**, Rutgers University.

*Multiple Combinatorial Numbers and Associated Identities* (Code: SS 8A), **Hasan Coskun**, Texas A&M University-Commerce.

*Multiscale Methods in Cell and Developmental Biology* (Code: SS 15A), **Anastasios Matzavinos**, Brown University, and **Chuan Xue**, Ohio State University.

*Nonlinear Waves in Differential Equations* (Code: SS 10A), **Linghai Zhang**, Lehigh University.

*Number theory, spectral theory, and homogeneous dynamics* (Code: SS 13A), **Dubi Kelmer**, Boston College, and **Alex Kontorovich**, Rutgers University.

*Partial Differential Equations in Geometric Analysis* (Code: SS 23A), **Jeffrey Case** and **Alice Chang**, Princeton University, and **Yi Wang**, Johns Hopkins University and Institute for Advanced Study.

*Probability, Combinatorics and Statistical Mechanics* (Code: SS 20A), **Nayantara Bhatnagar**, University of Delaware, **Brian Rider**, Temple University, and **Douglas Rizzolo**, University of Delaware.

*Representation Theory, Vertex Operator Algebras, and Related Topics* (Code: SS 7A), **Corina Calinescu**, New York City College of Technology, City University of New York, **Andrew Douglas**, New York City College of Technology and Graduate Center, City University of New York, and **Joshua Sussan**, Medgar Evers College, City University of New York.

*Representations of Reductive Groups* (Code: SS 11A), **Jeffrey Adams**, University of Maryland, **Stephen D. Miller**, Rutgers University, and **David Vogan**, Massachusetts Institute of Technology.

*Smooth and Symbolic Ergodic Theory* (Code: SS 21A), **Andrey Gogolev**, State University of New York at Binghamton, and **Federico Rodriguez Hertz** and **Zhiren Wang**, Pennsylvania State University.

*Topological Data Analysis: Computations, Statistics, and Applications* (Code: SS 18A), **Miroslav Kramar** and **Rachel Levanger**, Rutgers University.

# Seattle, Washington

*Washington State Convention Center and the Sheraton Seattle Hotel*

### January 6–9, 2016

*Wednesday – Saturday*

### Meeting #1116

*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: November 1, 2015
Program issue of electronic *Notices*: January 2016
Issue of *Abstracts*: Volume 37, Issue 1

### Deadlines

For organizers: Expired
For abstracts: September 22, 2015

*The scientific information listed below may be dated. For the latest information, see* `www.ams.org/amsmtgs/national.html`.

### Joint Invited Addresses

**Kristin Lauter**, Microsoft Research, *Title to be announced* (AMS-MAA Invited Address).

**Xiao-Li Meng**, Harvard University, *Title to be announced* (AMS-MAA Invited Address).

**Karen E Smith**, University of Michigan, *Title to be announced* (AWM-AMS Noether Lecture).

### AMS Invited Addresses

**Panagiota Daskalopoulos**, Columbia University, *Title to be announced.*

**Alex Eskin**, University of Chicago, *The $SL(2,\mathbb{R})$ action on moduli space.*

**Timothy A. Gowers**, University of Cambridge, *Generalizations of Fourier analysis, and how to apply them (Part I)* (AMS Colloquium Lectures: Lectures I, II, III).

**Marta Lewicka**, University of Pittsburgh, *Title to be announced.*

**Daniel A. Spielman**, Yale University, *Title to be announced* (AMS Josiah Willard Gibbs Lecture).

**David Vogan**, MIT, *Title to be announced* (AMS Retiring Presidential Address).

**Steven M. Zelditch**, Northwestern University, *Title to be announced.*

### 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* `jointmathematicsmeetings.org/meetings/abstracts/abstract.pl?type=jmm`.

**Some sessions are cosponsored with other organizations. These are noted within the parentheses at the end of each listing, where applicable.**

*Advances in Free Analysis: The Theory and Applications of Noncommutative Functions, Inequalities, and Domains* (Code: SS 26A), **Joseph A. Ball**, Virginia Polytechnic Institute, and **Paul S. Muhly**, University of Iowa, Iowa City.

*Advances in the Theory and Application of Reaction Diffusion Models* (Code: SS 38A), **Jerome Goddard, II**, Auburn University, and **Ratnasingham Shivaji**, University of North Carolina, Greensboro.

*Algebraic Theory of Differential and Functional Equations* (Code: SS 40A), **Taylor Dupuy**, Hebrew University of Jerusalem and University of Vermont, and **Alexey Ovchinnikov**, CUNY Queens College, New York.

*Algebraic and Topological Methods in Combinatorics* (Code: SS 3A), **Andrew Berget**, Western Washington University, **Steven Klee**, Seattle University, and **Isabella Novik**, University of Washington, Seattle.

*Analysis and Geometry in Nonsmooth Metric Measure Spaces* (Code: SS 5A), **Luca Capogna**, Worcester Polytechnic Institute, and **Jeremy Tyson**, University of Illinois at Urbana-Champaign.

*Analysis, Geometry, and Data* (Code: SS 43A), **Kevin R. Vixie**, Washington State University, Pullman, and **Bala Krishnamoorthy**, Washington State University, Vancouver.

*Analytic Function Spaces and Operators on Them* (Code: SS 62A), **Tim Ferguson** and **Hyun Kwon**, University of Alabama, Tuscaloosa.

*Analytic Methods in Geometry* (Code: SS 55A), **Eric Bahuaud** and **Dylan Helliwell**, Seattle University.

*Applications of Logic, Model Theory, and Theoretical Computer Science to Systems Biology* (Code: SS 20A), **James Lynch**, Clarkson University, and **Leo Marcus**, Santa Monica, CA (AMS-ASL).

*Applied and Computational Topology* (Code: SS 23A), **Pawel Dlotko**, INRIA Saclay, France, **Nicholas Scoville**, Ursinus College, and **Matthew Wright**, IMA University of Minnesota.

*Arithmetic Dynamics* (Code: SS 8A), **Matthew Baker**, Georgia Institute of Technology, and **Joseph Silverman**, Brown University.

*Big Demand for Big Data: How Do We Create the Big Supply?* (Code: SS 74A), **Rick Cleary**, Babson College, and **Xiao-Li Meng**, Harvard University.

*Classification Problems in Operator Algebras* (Code: SS 45A), **Marcel Bischoff** and **Ben Hayes**, Vanderbilt University.

*Combinatorial Design Theory* (Code: SS 60A), **Esther R. Lamken**, California Institute of Technology.

*Commutative Algebra* (Code: SS 37A), **Karen Smith**, University of Michigan, Ann Arbor, **Emily Witt**, University of Utah, and **Irena Swanson**, Reed College (AMS-AWM).

*Commutative Algebra and Its Interactions with Algebraic Geometry* (Code: SS 47A), **Daniel Hernández**, University of Utah, **Jack Jeffries**, University of Michigan, Ann Arbor, and **Karl Schwede**, University of Utah (AMS-AWM).

*Current Areas of Interest in the Mathematical Sciences of Medieval Islam* (Code: SS 35A), **Mohammad K. Azarian**, University of Evansville, and **Mohammad Javaheri** and **Emelie A. Kenney**, Siena College.

*Data-Intensive Modeling in Ecology* (Code: SS 57A), **Nikolay Strigul**, Washington State University, Vancouver, and **Bala Krishnamoorthy**, Washington State University, Vancouver.

*Difference Equations and Applications* (Code: SS 6A), **Michael A. Radin**, Rochester Institute of Technology.

*Distribution of Zeros of Entire Functions* (Code: SS 48A), **Matthew Chasse**, Rochester Institute of Technology, **Tamás Forgács**, California State University, Fresno, and **Andrzej Piotrowski**, University of Alaska Southeast, Juneau.

*Early Career Female Mathematicians in Algebra and Topology* (Code: SS 33A), **Jocelyn Bell**, United States Military Academy, West Point, **Bethany Kubik**, University of Minnesota, Duluth, and **Candice Price**, Sam Houston State University.

*Equations of Fluid Motion* (Code: SS 63A), **Elaine Cozzi** and **Radu Dascaliuc**, Oregon State University, and **James P. Kelliher**, University of California Riverside.

*Essential Mathematical Structures and Practices in K–12 Mathematics* (Code: SS 67A), **William McCallum**, University of Arizona, Tucson, **Kristin Umland**, University of New Mexico, and **Ellen Whitsides**, University of Arizona, Tucson.

*Fractal Geometry and Dynamical Systems* (Code: SS 13A), **John Rock**, Cal Poly Pomona, **Machiel van Frankenhuijesen**, Utah Valley University, and **Michel L. Lapidus**, University of California, Riverside.

*Geometric and Categorical Methods in Representation Theory* (Code: SS 11A), **Anthony Licata**, Australian National University, and **Julia Pevtsova**, University of Washington, Seattle.

*Global Harmonic Analysis* (Code: SS 70A), **Steven Zelditch**, Northwestern University, **Hart Smith**, University of Washington, Seattle, and **Chris Sogge**, Johns Hopkins University.

*Graduate Mathematics Courses and Programs for Secondary Mathematics Teachers* (Code: SS 36A), **James J. Madden**, Louisiana State University, Baton Rouge, and **James A. Mendoza Epperson**, University of Texas, Arlington.

*Graph Products* (Code: SS 9A), **Richard Hammack** and **Dewey Taylor**, Virginia Commonwealth University.

*Higher Genus Curves and Fibrations of Higher Genus Curves in Mathematical Physics and Arithmetic Geometry* (Code: SS 49A), **Andreas Malmendier**, Utah State University, Logan, and **Tony Shaska**, Oakland University, Rochester.

*Innovative Ideas in Enhancing Success in Mathematics Classes* (Code: SS 19A), **Natali Hritonenko**, Prairie View A&M University, **Ellina Grigorieva**, Texas Woman's University, and **Michael A. Radin**, Rochester Institute of Technology (AMS-MAA).

*Integrable Systems, Painlevé Equations, and Random Matrices* (Code: SS 64A), **Anton Dzhamay**, University of Northern Colorado, **Christopher M. Ormerod**, California Institute of Technology, and **Virgil U. Pierce**, University of Texas-Pan American.

*Interactions between Noncommutative Algebra, Algebraic Geometry, and Representation Theory* (Code: SS 2A), **Ellen Kirkman**, Wake Forest University, and **James Zhang**, University of Washington.

*Knots in Washington (State)* (Code: SS 41A), **Allison Henrich**, Seattle University, **Sam Nelson**, Claremont McKenna College, **Jozef Przytycki**, George Washington University, and **Radmila Sazdanovic**, North Carolina State University, Raleigh.

*Mathematical Information in the Digital Age of Science* (Code: SS 65A), **Patrick Ion**, University of Michigan, Ann Arbor, **Olaf Teschke**, zbMATH, Berlin, and **Stephen Watt**, University of Western Ontario.

*Mathematical Programming on Integral Invexity* (Code: SS 7A), **Ram Verma**, Texas State University, San Marcos, and **Alexander Zaslavski**, Israel Institute of Technology.

*Mathematics and Public Policy* (Code: SS 54A), **Paul Dreyer**, RAND Corporation.

*Mathematics in Natural Resource Modeling* (Code: SS 29A), **Catherine A. Roberts**, College of the Holy Cross, and **Shandele M. Henson**, Andrews University.

*Metrical and Topological Fixed Point Theory with Applications* (Code: SS 69A), **Clement Boateng Ampadu**, Boston, MA, **Talat Nazir**, Mälardalen University, Sweden, and **Hudson Akewe**, University of Lagos, Nigeria.

*Modular Forms, q-Series, and Mathematics Inspired by Ramanujan* (Code: SS 51A), **Chris Jennings-Shaffer**, University of Florida, Gainesville, and Oregon State University, Corvallis, and **Holly Swisher**, Oregon State University, Corvallis.

*Moduli Spaces in Algebraic Geometry* (Code: SS 66A), **Yaim Cooper**, Harvard University.

*Moduli Spaces in Symplectic Geometry* (Code: SS 50A), **Nathaniel Bottman**, MIT, **Joel Fish**, IAS, Princeton, and the University of Massachusetts, Boston, **Sheel Ganatra**, Stanford University, and **Katrin Wehrheim**, University of California Berkeley.

*Nonlinear Algebra* (Code: SS 4A), **Bernd Sturmfels**, University of California Berkeley, and **Rekha Thomas**, University of Washington, Seattle.

*Nonlinear Waves and Coherent Structures* (Code: SS 24A), **Natalie Sheils** and **Chris Swierczewski**, University of Washington, Seattle.

*Number Theory and Cryptography* (Code: SS 72A), **Matilde Lalin**, University of Montreal, **Michelle Manes**, University of Hawaii, Honolulu, and **Christelle Vincent**, University of Vermont.

*Operators, Function Spaces, and Models* (Code: SS 22A), **Alberto Condori**, Florida Gulf Coast University, Fort Myers, and **William Ross**, University of Richmond.

*Origami Methods and Applications* (Code: SS 44A), **Erik Demaine**, MIT, **Thomas C. Hull**, Western New England University, and **Robert J. Lang**, Lang Origami.

*Parabolic Geometries, Twistor Theory, and the AdS/CFT Correspondence* (Code: SS 39A), **Jonathan Holland** and **George Sparling**, University of Pittsburgh, and **Daniela Mihai**, Carnegie Mellon University.

*Partial Differential Equations in Complex Analysis* (Code: SS 28A), **Debraj Chakrabarti**, Central Michigan University, and **Yunus Zeytuncu**, University of Michigan, Dearborn.

*Problems and Challenges in Financial Engineering and Risk Management* (Code: SS 30A), **Matthew Lorig**, University of Washington, Seattle, and **Haijun Li** and **Hong-Ming Yin**, Washington State University, Pullman.

*Problems in Geometry and Design of Materials* (Code: SS 71A), **Marta Lewicka**, University of Pittsburgh, and **Petronela Radu**, University of Nebraska.

*Pseudorandomness and Its Applications* (Code: SS 73A), **Timothy Gowers**, University of Cambridge, and **Jozsef Solymosi**, University of British Columbia.

*Quantum Walks, Quantum Markov Chains, Quantum Computation and Related Topics* (Code: SS 15A), **Chaobin Liu**, Bowie State University, **Takyua Machida**, Japan Sociey for the Promotion of Science, **Salvador E. Venegas-Andraca**, Technológico de Monterrey, Mexico, and **Nelson Petulante**, Bowie State University.

*Random and Complex Dynamics of Reaction-Diffusion Systems* (Code: SS 27A), **Michael Anton Hoegele**, Universidad de Los Andes, Bogota, Colombia, and **Yuncheng You**, University of South Florida, Tampa.

*Recent Advances in Dynamical Systems and Mathematical Biology* (Code: SS 46A), **Guihong Fan**, Columbus State University, **Jing Li**, California State University Northridge, and **Hongying Shu**, Tongji University, China.

*Recent Advances in Orthogonal Polynomials and Special Functions* (Code: SS 17A), **Xiang-Sheng Wang**, Southeast Missouri State University, Cape Girardeau.

*Recent Developments in Dispersive Partial Differential Equations and Harmonic Analysis* (Code: SS 52A), **William Green**, Rose-Hulman Institute of Technology, Terre Haute, and **Jennifer Beichman**, University of Wisconsin, Madison.

*Representation Theory of Algebraic Groups* (Code: SS 10A), **Daniel K. Nakano**, University of Georgia, and **Cornelius Pillen**, University of South Alabama.

*Research by Posdocs of the Alliance for Diversity in Mathematics* (Code: SS 53A), **Aloysius Helminck**, North Carolina State University, Raleigh, and **Michael Young**, Iowa State University, Ames.

*Research from the 2014 and 2015 Rocky Mountain-Great Plains Graduate Research Workshop in Combinatorics* (Code: SS 58A), **Michael Ferrera**, University of Colorado, Denver, Greeley, **Leslie Hogben**, Iowa State University, Ames, **Paul Horn**, University of Denver, and **Derrick Stolee**, Iowa State University, Ames.

*Research in Mathematics by Undergraduates and Students in Post-Baccalaureate Programs* (Code: SS 25A), **Darren A. Narayan** and **Jobby Jacob**, Rochester Institute of Technology, **Tamas Forgacs**, California State University, Fresno, and **Ugur Abdulla**, Florida Institute of Technology (AMS-MAA-SIAM).

*Set-Valued Optimization and Variational Problems with Applications* (Code: SS 14A), **Baasansuren Jadamba** and **Akhtar A. Kahn**, Rochester Institute of Technology, **Mau Nam Ngyuen**, Portland State University, **Miguel Sama**, Universidad Nacional de Educacion a Distancia, Spain, and **Chirstiane Tammer**, Martin Luther University of Halle-Wittenberg.

*Special Functions and q-Series* (Code: SS 31A), **Richard Askey**, University of Wisconsin, Madison, **Mourad E. H. Ismail**, University of Central Florida and King Saud University, Riyadh, and **Erik Koelink**, Radboud University, Nijmegen, The Netherlands.

*Stochastic Effects in Models for Mathematical Biology and Ecology* (Code: SS 42A), **Olcay Akman**, Illinois State University, **Timothy D. Comar**, Benedictine University, and **Daniel Hrozencik**, Chicago State University.

*Stochastic Models in Population Biology* (Code: SS 61A), **Brian Dennis**, University of Idaho, Moscow, and **Eddy Kwessi**, Trinity University.

*Surreal Numbers* (Code: SS 16A), **Philip Ehrlich**, Ohio University, Athens, and **Ovidiu Costin**, Ohio State University, Columbus (AMS-ASL).

*Tensor Decompositions and Secant Varieties* (Code: SS 68A), **Zach Teitler**, Boise State University.

*Topological Graph Theory: Structure and Symmetry* (Code: SS 1A), **Jonathan L. Gross**, Columbia University, and **Thomas W. Tucker**, Colgate University.

*Topological Representation Theory* (Code: SS 56A), **Charles Frohman**, University of Iowa, Iowa City, and **Helen Wong**, Carelton College.

*Water Waves* (Code: SS 21A), **John Carter**, Seattle University, **Bernard Deconinck**, University of Washington, Seattle, and **Katie Oliveras**, Seattle University.

*What's New in Group Theory?* (Code: SS 32A), **Arturo Magidin**, University of Louisiana at Lafayette, and **Elizabeth Wilcox**, Oswego State University of New York.

*The History of Mathematics* (Code: SS 34A), **Patti Hunter**, Westmont College, **Adrian Rice**, Randolph-Macon College,

**Sloan Despeaux**, Western Carolina University, and **Deborah Kent**, Drake University (AMS-MAA).

*The Mathematics of Computation* (Code: SS 78A), **Susanne C. Brenner**, Louisiana State University.

# Athens, Georgia

*University of Georgia*

### March 5–6, 2016

*Saturday – Sunday*

### Meeting #1117

Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: August 5, 2015
For abstracts: January 19, 2016

*The scientific information listed below may be dated. For the latest information, see* www.ams.org/amsmtgs/sectional.html.

### Invited Addresses

**Michele Benzi**, Emory University, *Title to be announced.*

**Frank Garvan**, University of Florida, *Title to be announced.*

**William Graham**, University of Georgia, *Title to be announced.*

# Stony Brook, New York

*State University of New York at Stony Brook*

### March 19–20, 2016

*Saturday – Sunday*

### Meeting #1118

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: August 19, 2015
For abstracts: February 2, 2016

*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* www.ams.org/cgi-bin/abstracts/abstract.pl.

*Geometric Measure Theory and Its Applications* (Code: SS 2A), **Matthew Badger**, University of Connecticut, and **Christopher J. Bishop** and **Raanan Schul**, Stony Brook University.

*Invariants of Closed Curves on Surfaces* (Code: SS 1A), **Ara Basmajian**, Hunter College and Graduate Center, City University of New York.

# Salt Lake City, Utah

*University of Utah*

### April 9–10, 2016

*Saturday – Sunday*

### Meeting #1119

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: September 9, 2015
For abstracts: February 16, 2016
*The scientific information listed below may be dated. For the latest information, see* www.ams.org/amsmtgs/sectional.html.

### Invited Addresses

**Ravi Vakil**, Stanford University, *Cutting and pasting in algebraic geometry* (Erdős Memorial 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* www.ams.org/cgi-bin/abstracts/abstract.pl.

*Algebraic Geometry (association with the Erdős Lecture by Ravi Vakil)* (Code: SS 1A), **Ravi Vakil**, Stanford University, and **Christopher Hacon** and **Karl Schwede**, University of Utah.

*Inverse Problems* (Code: SS 2A), **Hanna Makaruk**, Los Alamos National Laboratory (LANL), and **Robert Owczarek**, University of New Mexico, Albuquerque and UNM, Los Alamos.

# Fargo, North Dakota

*North Dakota State University*

### April 16–17, 2016

*Saturday – Sunday*

### Meeting #1120

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: September 16, 2015
For abstracts: February 23, 2016

*The scientific information listed below may be dated. For the latest information, see* www.ams.org/amsmtgs/sectional.html.

### Invited Addresses

**Rodrigo Banuelos**, Purdue University, *Title to be announced.*

**Laura Matusevich**, Texas A&M University, *Title to be announced.*

**Jeff Viaclovsky**, University of Wisconsin-Madison, *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* www.ams.org/cgi-bin/abstracts/abstract.pl.

*Commutative Algebra and Its Interactions with Combinatorics and Algebraic Geometry* (Code: SS 4A), **Susan Cooper**, North Dakota State University, and **Adam Van Tuyl**, McMaster University.

*Commutative Ring Theory* (Code: SS 6A), **Catalin Ciuperca** and **Sean Sather-Wagstaff**, North Dakota State University.

*Convexity and Harmonic Analysis* (Code: SS 2A), **Maria Alfonseca-Cubero**, North Dakota State University, and **Dmitry Ryabogin**, Kent State University.

*Ergodic Theory and Dynamical Systems* (Code: SS 1A), **Dogan Comez**, North Dakota State University, and **Mrinal Kanti Roychowdhury**, University of Texas-Pan American.

*Integrable Dynamical Systems and Special Functions* (Code: SS 5A), **Oksana Bihun**, Concordia College.

*Mathematical Finance* (Code: SS 3A), **Indranil SenGupta**, North Dakota State University.

# Brunswick, Maine

*Bowdoin College*

### September 24–25, 2016

*Saturday – Sunday*

### Meeting #1121

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: To be announced
For abstracts: July 23, 2016

# Denver, Colorado

*University of Denver*

### October 8–9, 2016

*Saturday – Sunday*

### Meeting #1122

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: March 8, 2016
For abstracts: August 16, 2016

*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* www.ams.org/cgi-bin/abstracts/abstract.pl.

*Algebraic Logic* (Code: SS 1A), **Nick Galatos**, University of Denver, and **Peter Jipsen**, Chapman University.

*Analysis on Graphs and Spectral Graph Theory* (Code: SS 2A), **Paul Horn** and **Mei Yin**, University of Denver.

*Nonassociative Algebra* (Code: SS 3A), **Izabella Stuhl**, University of Debrecen and University of Denver, and **Petr Vojtěchovský**, University of Denver.

*Noncommutative Geometry and Fundamental Applications* (Code: SS 4A), **Frederic Latremoliere**, University of Denver.

*Operator Algebras and Applications* (Code: SS 5A), **Alvaro Arias**, University of Denver.

*Recent Trends in Semigroup Theory* (Code: SS 6A), **Michael Kinyon**, University of Denver, and **Ben Steinberg**, City College of New York.

*Set Theory of the Continuum* (Code: SS 7A), **Natasha Dobrinen** and **Daniel Hathaway**, University of Denver.

*Unimodularity in Randomly Generated Graphs* (Code: SS 8A), **Florian Sobieczky**, University of Denver.

*Vertex Algebras and Geometry* (Code: SS 9A), **Andrew Linshaw**, University of Denver, and **Thomas Creutzig**, University of Alberta.

*Zero Dimensional Dynamics* (Code: SS 10A), **Nic Ormes** and **Ronnie Pavlov**, University of Denver.

# Minneapolis, Minnesota

*University of St. Thomas*

### October 28–30, 2016

*Friday – Sunday*

### Meeting #1123

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: March 29, 2016
For abstracts: August 30, 2016

*The scientific information listed below may be dated. For the latest information, see* `www.ams.org/amsmtgs/sectional.html`.

### Invited Addresses

**Thomas Nevins**, University of Illinois Urbana-Champaign, *Title to be announced.*

**Charles Rezk**, University of Illinois Urbana-Champaign, *Title to be announced.*

**Christof Sparber**, University of Illinois at Chicago, *Title to be announced.*

**Samuel Stechmann**, University of Wisconsin-Madison, *Title to be announced.*

# Raleigh, North Carolina

*North Carolina State University at Raleigh*

### November 12–13, 2016

*Saturday – Sunday*

### Meeting #1124

Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: September 2016
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: April 12, 2016
For abstracts: To be announced

*The scientific information listed below may be dated. For the latest information, see* `www.ams.org/amsmtgs/sectional.html`.

### Invited Addresses

**Ricardo Cortez**, Tulane University, *Title to be announced.*

**Jason Metcalfe**, University of North Carolina at Chapel Hill, *Title to be announced.*

**Agnes Szanto**, North Carolina State University, *Title to be announced.*

# Atlanta, Georgia

*Hyatt Regency Atlanta and Marriott Atlanta Marquis*

### January 4–7, 2017

*Wednesday – Saturday*

### Meeting #1125

*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
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
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: November 10, 2016
For abstracts: To be announced

# Bloomington, Indiana

*Indiana University*

### April 1–2, 2017

*Saturday – Sunday*
Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: To be announced
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
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: To be announced
For abstracts: To be announced

# New York, New York

*Hunter College, City University of New York*

### May 6–7, 2017

*Saturday – Sunday*
Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: September 14, 2016
For abstracts: March 21, 2017

# Buffalo, New York

*State University of New York at Buffalo*

### September 16–17, 2017

*Saturday – Sunday*
Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: February 14, 2017
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
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: April 1, 2017
For abstracts: To be announced

# Baltimore, Maryland

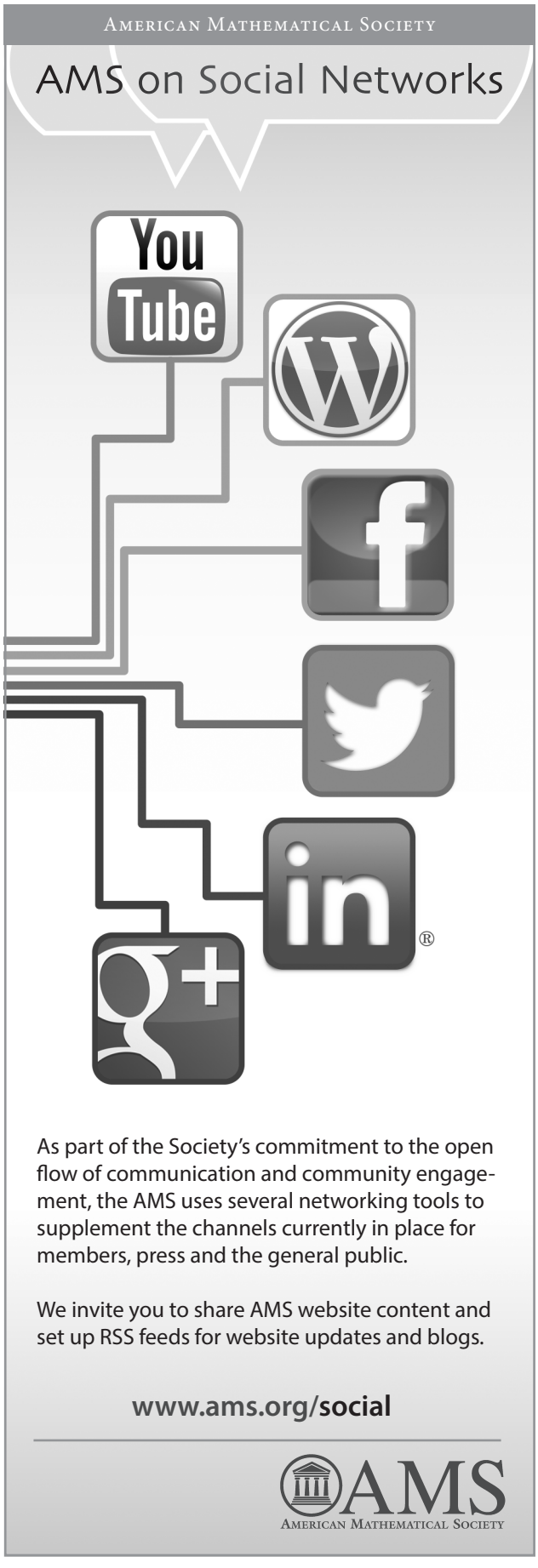
*Baltimore Convention Center, Hilton Baltimore, and Baltimore Marriott Inner Harbor Hotel*

### January 16–19, 2019

*Wednesday – Saturday*
*Joint Mathematics Meetings, including the 125th Annual Meeting of the AMS, 102nd 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 2018
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

### Deadlines

For organizers: April 2, 2018
For abstracts: To be announced

# Meetings and Conferences of the AMS


**Associate Secretaries of the AMS**

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**Eastern Section**: **Steven H. Weintraub**, Department of Mathematics, Lehigh University, Bethlehem, PA 18015-3174; 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:


**2015**

| | | |
|---|---|---|
| October 3–4 | Chicago, Illinois | p. 855 |
| October 17–18 | Memphis, Tennessee | p. 857 |
| October 24–25 | Fullerton, California | p. 859 |
| November 14–15 | New Brunswick, New Jersey | p. 863 |

**2016**

| | | |
|---|---|---|
| January 6–9 | Seattle, Washington<br>Annual Meeting | p. 864 |
| March 5–6 | Athens, Georgia | p. 867 |
| March 19–20 | Stony Brook, New York | p. 867 |
| April 9–10 | Salt Lake City, Utah | p. 867 |
| April 16–17 | Fargo, North Dakota | p. 868 |
| September 24–25 | Brunswick, Maine | p. 868 |
| October 8–9 | Denver, Colorado | p. 868 |
| October 28–30 | Minneapolis, Minnesota | p. 869 |
| November 12–13 | Raleigh, North Carolina | p. 869 |

**2017**

| | | |
|---|---|---|
| January 4–7 | Atlanta, Georgia<br>Annual Meeting | p. 869 |
| March 10–12 | Charleston, South Carolina | p. 870 |
| April 1–2 | Bloomington, Indiana | p. 870 |
| April 22–23 | Pullman, Washington | p. 870 |
| May 6–7 | New York, New York | p. 870 |
| September 16–17 | Buffalo, New York | p. 870 |

**2018**

| | | |
|---|---|---|
| January 10–13 | San Diego, California<br>Annual Meeting | p. 870 |

**2019**

| | | |
|---|---|---|
| January 16–19 | Baltimore, Maryland<br>Annual Meeting | p. 871 |


## Important Information Regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 200 in the February 2015 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 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 www.ams.org/meetings/ for the most up-to-date information on these conferences.)

**December 16–19, 2015:** Amrita School of Engineering hosts the International Conference on Graph Theory and its Applications, Tamil Nadu, India (For further information see https://www.amrita.edu/site/icgta15/.)

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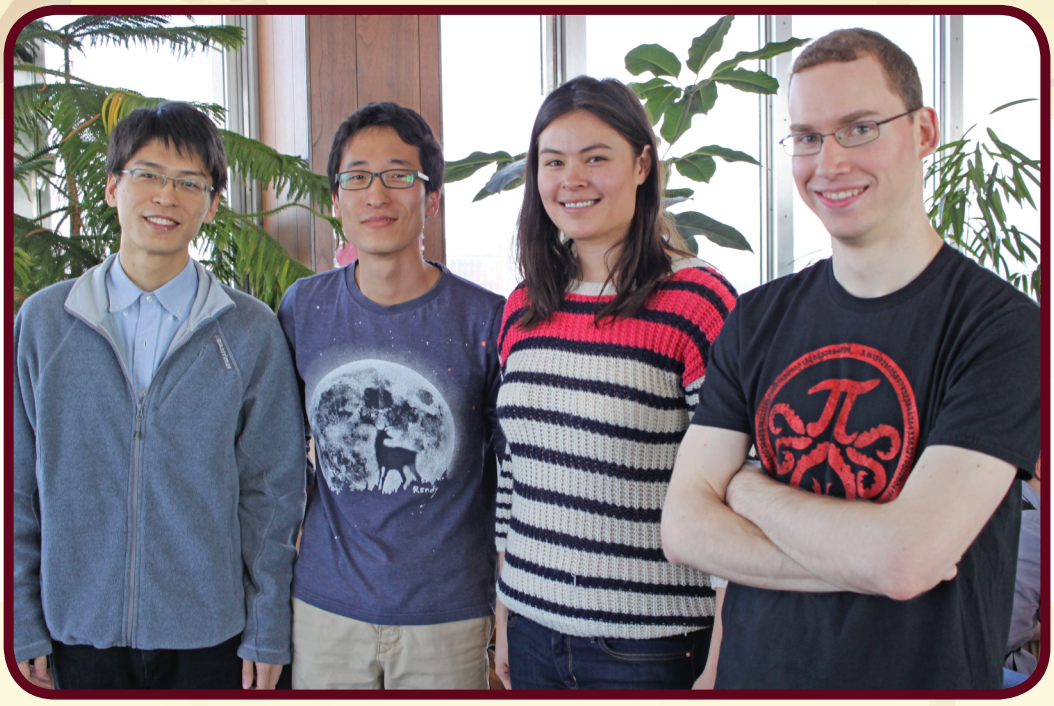

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# Summer Reading Sale

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## Lipman Bers, a Life in Mathematics

**Linda Keen,** *Lehman College, CUNY, New York, NY*, **Irwin Kra,** *Stony Brook University, NY*, **and Rubí E. Rodríguez,** *Pontificia Universidad Católica de Chile, Santiago, Chile*, **Editors**

This book is all about Lipman Bers. It captures the essence of his mathematics and his personality. It contains autobiographical material and short reprints of his work.

2015; approximately 335 pages; Softcover; ISBN: 978-1-4704-2056-7; List US$44; AMS members US$35.20; Order code MBK/93

## Lars Ahlfors – At the Summit of Mathematics

**Olli Lehto,** *University of Helsinki, Finland*

**Translated by William Hellberg**

This book tells the story of the Finnish-American mathematician Lars Ahlfors (1907-1996) and concentrates on his contributions to the general development of complex analysis.

2015; 125 pages; Softcover; ISBN: 978-1-4704-1846-5; List US$39; AMS members US$31.20; Order code MBK/92

## Unity and Disunity and Other Mathematical Essays

**Philip J. Davis,** *Brown University, Providence, RI*

This book is written in a nontechnical fashion and contains observations or incidental remarks on mathematics, its nature, its impacts on education and science and technology, its personalities and philosophies.

2015; 149 pages; Softcover; ISBN: 978-1-4704-2023-9; List US$39; AMS members US$31.20; Order code MBK/94

## Art in the Life of Mathematicians

**Anna Kepes Szemerédi,** *ELTE, Budapest, Hungary*, **Editor**

Mathematicians reflect on the roles that mathematics and art have played in their lives.

2015; 282 pages; Hardcover; ISBN: 978-1-4704-1956-1; List US$49; AMS members US$39.20; Order code MBK/91

## Peter Lax, Mathematician

### An Illustrated Memoir

**Reuben Hersh,** *University of New Mexico, Albuquerque, NM*

*Reuben Hersh, a former student of Peter Lax, has produced a wonderful account of the life and career of this remarkable man. The book is well researched and full of interesting facts, yet light-hearted and lively. It is very well written. A nice feature is the abundance of photographs, not only of Peter Lax and his family, but also of colleagues and students. Although written for mathematicians, the book will have wider appeal. Highly recommended.*

***—Peter Duren, University of Michigan***

A book about the life of Peter Lax, one of the most famous and influential mathematicians of the modern era.

2015; 253 pages; Softcover; ISBN: 978-1-4704-1708-6; List US$35; AMS members US$28; Order code MBK/88

## Really Big Numbers and You Can Count on Monsters (2-Volume Set)

**Richard Evan Schwartz,** *Brown University, Providence, RI*

These books are unique teaching tools that take math lovers on a journey designed to motivate kids (and kids at heart) to learn the fun of numbers.

2015; 436 pages; Softcover; ISBN: 978-1-4704-2294-3; List US$40; AMS members US$32; Order code MBK/84/90

## The War of Guns and Mathematics

### Mathematical Practices and Communities in France and Its Western Allies around World War I

**David Aubin,** *Sorbonne Universités, Université Pierre et Marie Curie, Institut de mathématiques de Jussieu-Paris Rive Gauche, France*, **and Catherine Goldstein,** *CNRS, Institut de mathématiques de Jussieu-Paris Rive Gauche, France*, **Editors**

This book suggests a new vision of the long-term influence of World War I on mathematics and mathematicians.

**History of Mathematics**, Volume 42; 2014; 391 pages; Hardcover; ISBN: 978-1-4704-1469-6; List US$126; AMS members US$100.80; Order code HMATH/42

## Mathematics Across the Iron Curtain

### A History of the Algebraic Theory of Semigroups

**Christopher Hollings**

*Hollings has done a masterful job. The book is well written, both in telling the story and in explaining the mathematics involved. It is an important and valuable contribution to the history of mathematics in the 20th century. This book should be in the libraries of all research institutions, and on the shelves of those interested in the history of abstract algebra, as well as those of semigroup researchers.*

***—MAA Reviews***

This book describes the evolution of (algebraic) semigroup theory from its earliest origins to the establishment of a full-fledged theory.

**History of Mathematics**, Volume 41; 2014; 441 pages; Hardcover; ISBN: 978-1-4704-1493-1; List US$109; AMS members US$87.20; Order code HMATH/41

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