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The August issue offers a variety of treats:

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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A M E R I C A N M A T H E M A T I C A L S O C I E T Y

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.

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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.

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Search Committee—Education and Diversity
c/o Executive Director’s Office
American Mathematical Society
201 Charles Street
Providence, RI 02904-2294 USA

Or email to: aed-mps@ams.org

Confidential inquiries about the position can be directed to T. Christine Stevens (aed-mps@ams.org) or Donald E. McClure (exdir@ams.org).

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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.

In the third stage, we worked with experts to identify logical relationships within proofs and used this knowledge to design a tool that might support students in reading proofs effectively. We conducted a large-scale experiment to test the effectiveness of this tool and found that students who used it learned more than those who did not, and that they were also more engaged with the material.

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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.

Figures 5, 8, 9, 10, and 11 have been adapted with permission from the Journal for Research in Mathematics Education, ©2012, 2014, by the National Council of Teachers of Mathematics.
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-

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**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.”
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 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 $\times$ 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.
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.
Theorem. There are infinitely many primes that can be written as $4k + 1$ (where $k \in \mathbb{Z}$).

Proof. Suppose there are finitely many primes of the form $4k + 1$.

Then these primes can be listed $p_1, p_2, p_3, \ldots, p_n$.

Define a number $a$ as follows. Let $a = p_1p_2p_3 \cdots p_n + 4$.

Note that dividing $a$ by 4 leaves remainder 1.

Every number that leaves remainder 1 when divided by 4 is divisible by a prime that also leaves remainder 1 when divided by 4.

However, for all $i$ such that $1 \leq i \leq n$, $p_i$ divides $p_1p_2p_3 \cdots p_n$ and $p_i$ does not divide 4.

Thus $p_i$ does not divide $a$.

So dividing $a$ by 4 leaves remainder 1 and $a$ is not divisible by any prime that leaves remainder 1 when divided by 4.

This is a contradiction.

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Thus $p_i$ does not divide $a$.

So dividing $a$ by 4 leaves remainder 1 and $a$ is not divisible by any prime that leaves remainder 1 when divided by 4.

This is a contradiction.
 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 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](http://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).](image)

![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.](image)
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. 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.

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.

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, $F(1,27) = 8.850, p = .006, \eta_p^2 = .247$, but no significant effect of proof order and no significant condition-by-proof-order interaction, both $F$s $< 1$.

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, $ps > .3$. 

2An 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, $F(1,27) = 8.850, p = .006, \eta_p^2 = .247$, but no significant effect of proof order and no significant condition-by-proof-order interaction, both $F$s $< 1$.

3An 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 9. Design for the study of the effects of self-explanation training on eye movements ([22], p. 74).
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, \(F(1,22) = 10.394, p = .004, \eta^2_p = 0.321\), and a significant effect of proof order, \(F(1,22) = 8.449, p = .008, \eta^2_p = 0.277\), but no significant interaction between condition and proof order, \(p = .742\).

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 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

\(^3\) 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.

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, \(F(1,105) = 6.024, p = .016, \eta^2_p = 0.054\), 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.
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.

References


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Mathematics in Kenya

Tom Denton

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

Fishermen on Lake Victoria.

Tom Denton was a math researcher and educator, working as a postdoctoral researcher at York University. He is now employed by Google. His email address is sdenton4@gmail.com.

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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).
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 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.
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 Odeke, and Evan Green-Lowe, were mostly working with international non-governmental organizations (NGOs) but interested in jump-starting 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.

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
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William B. Arveson: A Tribute

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

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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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...
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,
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 Dritichel 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 whipper snappers 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 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 I_{I_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 I_{I_1} factor case without the least difficulty; statements, definitions and proofs, remain virtually unchanged. One has, for example, the extension

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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.

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...
there has been an uptick in the interest in [1], and I suspect—indeed, 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: $d_{\alpha \beta} = d_\alpha + d_\beta$.

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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 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.

**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 dachshund.

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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.

**References**

15. V. Paulsen et al., see arXiv.
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The American Mathematical Society invites undergraduate mathematics and computer science majors in the U.S. to apply for a special scholarship to attend a semester in the Math in Moscow program, run by the Independent University of Moscow.

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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.

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.

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

• US academic hiring increased 5% to 926 compared to 878 last year.
• Government 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.
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

- 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.

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%.

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).

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

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.

*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.
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

<table>
<thead>
<tr>
<th>Department Grouping</th>
<th>Females Produced</th>
<th>Females Hired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math Public Large</td>
<td>89</td>
<td>30</td>
</tr>
<tr>
<td>Math Public Medium</td>
<td>99</td>
<td>26</td>
</tr>
<tr>
<td>Math Public Small</td>
<td>58</td>
<td>12</td>
</tr>
<tr>
<td>Math Private Large</td>
<td>42</td>
<td>17</td>
</tr>
<tr>
<td>Math Private Small</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>Applied Math</td>
<td>54</td>
<td>8</td>
</tr>
<tr>
<td>Statistics</td>
<td>143</td>
<td>10</td>
</tr>
<tr>
<td>Biostatistics</td>
<td>96</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>608</strong></td>
<td><strong>118</strong></td>
</tr>
</tbody>
</table>

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

- 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%.

- 27% of all PhDs awarded were in Statistics/Biostatistics.
- Females account for 41% of statistics and 57% of biostatistics PhDs awarded.
- Females accounted for 47% of the 519 PhDs in Statistics and Biostatistics, compared to all other groups combined, where 26% are female.
- 41% of Statistics/Biostatistics US citizen PhD recipients are females, while in all other groups combined 25% of the US citizens are females.

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.

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.
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.

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.

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.

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Perm Total</th>
<th>Perm %</th>
<th>Temp Total</th>
<th>Temp %</th>
<th>Perm Not Avail</th>
<th>% of Temp Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2010</td>
<td>320</td>
<td>48%</td>
<td>341</td>
<td>52%</td>
<td>140</td>
<td>41%</td>
</tr>
<tr>
<td>Fall 2011</td>
<td>251</td>
<td>44%</td>
<td>319</td>
<td>56%</td>
<td>133</td>
<td>42%</td>
</tr>
<tr>
<td>Fall 2012</td>
<td>261</td>
<td>44%</td>
<td>328</td>
<td>56%</td>
<td>127</td>
<td>39%</td>
</tr>
<tr>
<td>Fall 2013</td>
<td>374</td>
<td>53%</td>
<td>335</td>
<td>47%</td>
<td>173</td>
<td>52%</td>
</tr>
<tr>
<td>Fall 2014</td>
<td>363</td>
<td>51%</td>
<td>343</td>
<td>49%</td>
<td>148</td>
<td>43%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Perm Total</th>
<th>Perm %</th>
<th>Temp Total</th>
<th>Temp %</th>
<th>Perm Not Avail</th>
<th>% of Temp Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2010</td>
<td>246</td>
<td>72%</td>
<td>68</td>
<td>28%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Fall 2011</td>
<td>225</td>
<td>71%</td>
<td>87</td>
<td>39%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Fall 2012</td>
<td>242</td>
<td>74%</td>
<td>108</td>
<td>45%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Fall 2013</td>
<td>247</td>
<td>74%</td>
<td>106</td>
<td>43%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Fall 2014</td>
<td>260</td>
<td>76%</td>
<td>88</td>
<td>34%</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Year</th>
<th>Permanent</th>
<th>Temporary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acad</td>
<td>Govn</td>
</tr>
<tr>
<td>Fall 2010</td>
<td>64%</td>
<td>8%</td>
</tr>
<tr>
<td>Fall 2011</td>
<td>61%</td>
<td>8%</td>
</tr>
<tr>
<td>Fall 2012</td>
<td>61%</td>
<td>8%</td>
</tr>
<tr>
<td>Fall 2013</td>
<td>53%</td>
<td>7%</td>
</tr>
<tr>
<td>Fall 2014</td>
<td>54%</td>
<td>6%</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>PhD Year</th>
<th>Min</th>
<th>Q₁</th>
<th>Median</th>
<th>Q₃</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>53.0**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall 2014</td>
<td>25.0</td>
<td>50.0</td>
<td>54.0</td>
<td>60.0</td>
<td>85.0</td>
</tr>
<tr>
<td>One year or less experience (151 male/97 female)</td>
<td>25.0</td>
<td>50.0</td>
<td>53.0</td>
<td>60.0</td>
<td>160.0</td>
</tr>
</tbody>
</table>

Academic Postdoctorates Only*

9–10-Month Starting Salaries (in thousands of dollars)

<table>
<thead>
<tr>
<th>PhD Year</th>
<th>Min</th>
<th>Q₁</th>
<th>Median</th>
<th>Q₃</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall 2014</td>
<td>30.0</td>
<td>46.0</td>
<td>51.5</td>
<td>55.0</td>
<td>85.0</td>
</tr>
</tbody>
</table>

** 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)

<table>
<thead>
<tr>
<th>PhD Year</th>
<th>Min</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (28 male/10 female)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014 M</td>
<td>60.0</td>
<td>75.0</td>
<td>88.2</td>
<td>99.0</td>
<td>150.0</td>
</tr>
<tr>
<td>2014 F</td>
<td>47.0</td>
<td>58.0</td>
<td>70.0</td>
<td>84.9</td>
<td>105.0</td>
</tr>
<tr>
<td>One year or less experience (24 male/10 female)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014 M</td>
<td>60.0</td>
<td>75.0</td>
<td>87.1</td>
<td>96.8</td>
<td>130.0</td>
</tr>
<tr>
<td>2014 F</td>
<td>47.0</td>
<td>61.6</td>
<td>70.0</td>
<td>88.8</td>
<td>105.0</td>
</tr>
</tbody>
</table>

**Business and Industry**

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

<table>
<thead>
<tr>
<th>PhD Year</th>
<th>Min</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (108 male/39 female)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014 M</td>
<td>56.0</td>
<td>85.5</td>
<td>100.0</td>
<td>120.0</td>
<td>300.0</td>
</tr>
<tr>
<td>2014 F</td>
<td>50.0</td>
<td>80.0</td>
<td>91.0</td>
<td>101.0</td>
<td>140.0</td>
</tr>
<tr>
<td>One year or less experience (93 male/35 female)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014 M</td>
<td>56.0</td>
<td>85.5</td>
<td>100.0</td>
<td>120.0</td>
<td>300.0</td>
</tr>
<tr>
<td>2014 F</td>
<td>50.0</td>
<td>79.5</td>
<td>86.0</td>
<td>101.0</td>
<td>140.0</td>
</tr>
</tbody>
</table>

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 a triangle 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 a star in the boxplot.
## 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](http://www.ams.org/notices/201209/rtx120901262p.pdf).

Listings of the actual departments which compose these groups are available on the AMS website at [www.ams.org/annual-survey/groups](http://www.ams.org/annual-survey/groups).

### Survey Response Rates by New Groupings

**Doctorates Granted**

**Departmental Response Rates**

<table>
<thead>
<tr>
<th>Group</th>
<th>Total</th>
<th>26 of 26 including 0 with no degrees</th>
<th>40 of 40 including 0 with no degrees</th>
<th>64 of 64 including 8 with no degrees</th>
<th>24 of 24 including 0 with no degrees</th>
<th>28 of 28 including 4 with no degrees</th>
<th>31 of 31 including 2 with no degrees</th>
<th>58 of 58 including 1 with no degrees</th>
<th>44 of 44 including 13 with no degrees</th>
<th>315 of 315 including 28 with no degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math Public Large</td>
<td></td>
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<tr>
<td>Math Public Medium</td>
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<td>Math Public Small</td>
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<tr>
<td>Math Private Large</td>
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<tr>
<td>Math Private Small</td>
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<td>Group M</td>
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### 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](http://www.ams.org/annual-survey/surveyreports.html).

### 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.
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
e-mail 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
e-mail 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 infor-
mation 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
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, Kodithuwakku Arachchige Avanthika, 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
Mikononaka, 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 flows

University of Alabama at Birmingham (9)
DEPARTMENT OF BIOSTATISTICS
Mehta, Tapas, 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 Schrodinger'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 Todala 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 a 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 multiparticle 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 Schrödinger 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 Szegő 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

Tyranoowski, 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 mnemonic 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 “Mehrstellen” 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 HCl2 and ZnCl2

Naval Postgraduate School (1)

Department of Applied 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

Petrov, 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, Darla, Loop group actions on categories and Whittaker invariants
Boocher, Adam, Super flatness
Bray, Nicolaus, Methods for measurement and interpretation of gene expression
Chiralambidis, 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
McDougall, 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 CP^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
Huo, 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
Brammitt, 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, Lingyuan, 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
Chow, 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, Yingkan, 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
Rickertson, 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 Local indecomposability of Hilbert modular representations and Mumford-Tate conjecture
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

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

Briggs, Christopher, Uniform exponential growth in algebras
Gao, Teng, A rearrangement inequality 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

Department of Mathematics

Brphas, Christopher, Uniform exponential growth in algebras
Gao, Teng, A rearrangement inequality for diffusion process
Meredith, Michael Brandon, Mirror symmetry on toric varieties via tropical geometry
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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

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, Marce, The structure of fundamental groups of smooth metric measure spaces
Plunkett, Patrick, Spatially adaptive numerical methods for stochastic biophysical processes
Sigrudsson, Jon Karl, Continuum and coarse-grained modeling of lipid bilayer membranes
Speer, Timothy, Isometries of the Hilbert metric

University of California, Santa Cruz

Department of Mathematics

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

University of Southern California

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 bivariate cyclic cohomology
Chubatiuk, Alona, Nonparametric estimation of an unknown probability distribution using maximum likelihood and Bayesian approaches
Eriksen, Adam, The geometry of motivic spheres
Marinov, Radoslav, Applications of Stein’s methods on statistics of random graphs
Ostrovyitki, Vitali, 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

Department of Applied Mathematics and Statistics

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

Colorado State University

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

Department of 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 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

University of Colorado, Denver

Department of Mathematics

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

Feaver, Amy, Euclid’s algorithm in multiquadratic 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 nonstandard 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

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

Ganathilaka, 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 class 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

Rayappolu, 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

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
Doctoral Degrees Conferred

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

Fraley, 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, Quanhui, 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, Ruifeng, Analysis of mixed types of traits in genetic association studies and application to genome-wide association studies

Xu, Wenhua, 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, Bertram, 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

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Department of Mathematics
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ILLINOIS

Illinois Institute of Technology (1)

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University of Louisiana at Lafayette (4)

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University of Maryland, College Park (16)

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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 \( \mathbb{Q}(\sqrt{d}, i) \)

Clominger, Alexander, Exploiting data-dependent structure for improving sensor reduction 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, Saba, Minimal models of human-nature interaction

Otarola Fasten, 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

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Yu, Wei-Hsuan, Spherical two-distance sets and related topics in harmonic analysis

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

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

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Harvard U, School of Public Health (14)

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Alexeiff, 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

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Mukherjee, Rajarshi, Statistical inference for high dimensional problems

Rader, Kevin, Methods for analyzing survival and binary data in complex surveys

Satthirapongsasuti, Jarupon Fah, Post-genomic approaches to personalized medicine: Applications 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 Huang, Bao Viet, Modularity of some elliptic curves over totally real fields

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Culler, Lucas, The blowup formula for higher rank Donaldson invariants

Deckelbaum, Alan, The structure of auctions: Optimality and efficiency

DeFranco, Mario, The unraveled principal series at \( p \)-adic groups the Bessel function

Gonzalez Ramirez, Laura, Existence and stability of traveling waves in a biologically constrained model of seizure wave propagation

Huang, Norman, The blowup formula for higher rank Donaldson invariants

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Jackson-Hansen, David, Symplectic cohomology of contractible surfaces
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Park, Jennifer, Effective Chabauty for symmetric powers of curves
Tsymbaliuk, Oleksandr, The affine Yangian of gl, and the infinitesimal Cherednik algebras
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Northeastern University (6)

Department of Mathematics
Appel, Andrea, Monodromy theorems in the affine setting
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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, Guifang, 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
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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
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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 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

University of Michigan (11)

Department of Mathematics
Bao, Lian Zhang, Some properties of backward 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
Kratovich, David, The reduced knot Floer complex
Maridakis, Manousos, The concentration principle
Reznikov, Oleksandr, Weighted norm inequalities for Calderon-Zygmund operators
Shadrach, Richard, Integral models of certain PEL Shimura varieties with $F_1(p)$-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

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 computing 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
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Abram, William, Equivariant complex cobordism

Altschul, Samuel, Endoscopy for nilpotent orbits of $G_2$

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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

Caldar, Emily, The Landau-Ginzburg/Calabi-Yau correspondence for certain complete intersections

Ford, Nicolas, Geometric shifts and posttoid varieties

Gignac, William, Equidistribution of preimages in nonarchimedean dynamics

Gu, Huaying, 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 arithmetic of multiple harmonic sums

Sadig, 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

Talafkh, Yousof, Two-time scale systems in continuous time with regime switching and their applications

Tilson, Sean, Power operations in the Kunneth and $C_2$-equivariant Adams spectral sequences with applications

Tran, Nghia, Full stability in optimization

Xiao, Yayaun, 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, Naphthalin, Elementary school teachers’ use of curricular resources for lesson design and enactment

Bulut, Alper, Lie loops associated with GL(2), 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, Janelle (Julie), A pattern in the Lusztig-Schubert-Sahi category of rational spaces

Kipka, Robert, Mathematical methods of analysis for control and dynamic optimization problems on manifolds

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Burgos, Jaime, Multivariate autoregressive time series using Schweppe weighted Wilcoxon estimates

Jelsena, 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, Yifei, 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 polyelectrolyte 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-Ampere equations and Chern-Ricci flow on Hermitian manifolds

Oestreicher, Samantha, Forced oscillators with dynamic Hopf bifurcations and applications to Paleoclimate

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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
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Sonnyn, Sanyal, Irrational behavior of algebraic discrete valuations
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Dey, Rima, Random set models for growth with applications to nowcasting
Gladish, Daniel, Spatio-temporal models with time-varying spatial model error for environmental 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, Haifying, 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
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Zlotnik, Anatoly, Optimal control and synchronization of dynamic ensemble systems

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Bouwman, Andrew, L-cuts for genus 2 translation surfaces
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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
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Severino, Michael, Digraphs and morphisms: Core, construction, and colorings

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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
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Gibbons, Courtney, Decompositions of Betti diagrams
Haymaker, Kathryn, Combinatorial and algebraic coding techniques for flash memory storage
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Black, Michael, Informative retesting for hierarchical group testing
Claassen, Elizabeth, A reduced bias method of estimating variance components in generalized linear mixed models
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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)

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Dartmouth College (10)

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Mathematics Department

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Craig, Kat, The exponential formula for the Wasserstein metric
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Wang, Yu, Curvature and statistics
Yang, Jinhui, Some results in the representation theory of strongly graded vertex algebras

New Mexico

New Mexico State University, Las Cruces

Jaraadat, Imad, Equivariant triviality of proper G_a^r-actions on A^r
Tchamna Kouna, Simplice, The ideal completion of a Noetherian local domain
Yang, Taewon, The logic of bundles

University of New Mexico

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Byrne, Martha, Changes in student proving skills and attitudes following a cooperative learning seminar
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White, Bryan, Star operations and numerical semigroup rings

New York

Binghamton University

Jafarif, Fatima Zohra, Adaptive methods for estimating the mean of finite population
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McCulloch, Ryan, The Chermak-Delgado lattice of finite groups
Minemyer, Barry, Isometric embeddings of polyhedra
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Wu, Xiaolei, Farrell-Jones conjecture for the solvable Baumslag-Solitar groups

Clarkson University

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Fowler, Michael, Generalized uncertainty quantification for linear inverse problems in X-ray imaging
Hu, Wenjin, Quantitative investigation of the technologies that support Cloud computing
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Kramer, Sean, Oceanographic modeling with hyperspectral satellite data
Li, Na, Variants of ALS method and source apportionment application
Mihajlovikj, Vidoje, Hybrid layout of metabolic networks
Opperman, Michael, Graphs with perfect state transfer in quantum walks

Columbia University

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Chen, Tianle, Statistical modeling and statistical learning for disease classification and prediction
Ciarelleglio, Adam, On scalar-on-function regression
Hu, Chih-Chi, Sequential quantile estimation using continuous outcomes with applications in dose finding
Jia, Xiaoyu, Two-stage continual reassessment method and patient heterogeneity for dose-finding studies
Yu, Gary, Identifying patterns in behavioral public health data mixture modeling with an informative number of repeated measures

Rutgers, The State University of New Jersey

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Agarwal, Monica, On Rota-Baxter Nijenhuis TD-algebra
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Stevens Institute of Technology

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Zhang, Yi Di, Groups and ordinals by automata

Minemyer, Barry, Isometric embeddings of polyhedra
Ruiz, Amanda, Realization spaces of phased matroids
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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

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Albert Baernstein II
1941–2014

David Drasin

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 ★-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 $f$ or domains $D$, and the issue is to show that a given functional $\Phi$ is maximized, when restricted to either $f$ or $D$, 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-Szegö [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

$$f(z) = \prod_n \left(1 - \frac{z}{a_n}\right)$$

(without the assumption of small order, this infinite product will not converge). Their special, defining

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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 $p$ 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 $|f(re^{i\theta}) - a|$ will be
small on a $\delta$-set of angular measure of at least
$$\min \left( \frac{4}{\rho} \sin^{-1} \left( \frac{\delta}{\sqrt{2}} \right) \right)$$
(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
$$T^*(re^{i\theta}) = \max_{|E|=2\theta} \int_H \log|f(re^{i\psi})| \, d\psi,$$
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 $p > 1$) 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 break-
through 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 confer-
ces and symposia. The results of many of these
presentations remain in the literature as surveys
and orientations on a wide variety of topics.
Walter Hayman recalls the contemporary impact
of $T^*$: “I remember well when I first met Al

property is that all zeros $\{a_n\}$ lie on the negative
real axis.

Since the 1920s the standard method to study en-
tire and meromorphic functions has been with Rolf
Nevanlinna’s value-distribution theory and charac-
teristic function $T(r), r > 0$; its most famous result
is a deep and systematic generalization of E. Pi-
card’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
$$T(r) = \frac{1}{2\pi} \int_{r e^{i\theta} \in P} \log |f(re^{i\theta})| \, d\theta \quad (0 < r < \infty),$$
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
$\Gamma^* = \{re^{-i\beta(r)}; r > 0\}$. 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
$\Gamma, \Gamma^*$ is unspecified—only the values of $f$ on them
are given—but one consequence of this theorem is
that $\Gamma$ and $\Gamma^*$ 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

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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 $S : f(z) = z + \sum_{j=2}^{\infty} a_j z^j$ in the unit disk $D := \{ |z| < 1 \}$. The presumed extremal function $k(z) = \frac{z}{(1 - z)_r^2} = \sum_{j=1}^{\infty} jz^j$ (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 $\frac{1}{2\pi} \int_0^{2\pi} \Phi(\frac{1}{r} \log |f(re^{i\theta})|) \, d\theta$ 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.

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,”

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

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 praise-worthy. 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), cliui 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...
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):

\[
\text{Utile erit scribi } \int \text{ pro omn., ut } \ell \text{ pro omn. } \ell, \text{ id est summa ipsorum } \ell. \text{ Itaque fiet } \frac{\ell^2}{2a} \int \frac{\ell}{a} \text{ et } \int x^2 \int x^2 - \int \ell. \text{ Et ita apparebit semper observari legem homogeneorum, quod utile est ut calculi errores vitentur. Nota: si analytice detur } \int \ell, \text{ dabitur etiam } \ell. \text{ Ergo si detur } \int \int \ell, \text{ dabitur etiam } \ell, \text{ sed non si datur } \ell, \text{ dabitur et } \ell.\]

\text{Semper } x \int \frac{x^2}{2}.

In the English of J. M. Child, this starts out

\text{It will be useful to write } \int \text{ for omn., so that } \int \ell \sqsupset \text{omn. } \ell, \text{ or the sum of the } \ell \text{’s.}

Here omn is an abbreviation of \text{omnia, which for} Leibniz means an infinite sum of all of something. He writes $\sqsupset$ for $\times$. 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

\[
\frac{(\int \ell)^2}{2} \sqsupset \int \left( \int \ell \right),
\]

or in our only slightly different terminology

\[
\frac{x^2}{2} \sqsupset \int x dx.
\]

He also exhibits a version of what we know as integration by parts that eventually gives him:

\[
\int x^2 dx \sqsupset \frac{x^3}{3}.
\]

References for this material include:


  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.


  The passage at hand is on p. 80.


  This an extremely enjoyable account.


  Pages 252–254 are about this memorandum.

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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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 $R^n$-actions on $n$-manifolds,” Journal of the Mathematical Society of Japan 66 (2014), no. 3, 839–894; and to HIDE-
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 KHIRSAGAR, 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
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 BABA, 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 \( SL_2 \mathbb{Z} \). 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

—Bruce C. Berndt, Wen-Ching Winnie Li, and J. R. Smart
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. 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/mimosc 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.abel-prize.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
Mathematics Opportunities

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 Lectureship 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:
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 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

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 pre-conference activity of the SACNAS National Conference (Society for Advancement of Hispanics/Chicanos and Native Americans in Science; see www.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 recent PhDs are encouraged to attend the workshop. For more information and to register, please see www.msri.org/e/MMW2015.

—From an MSRI announcement

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

Mathematics Opportunities
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
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
and engineering. This album includes images of works by Richard Palais, University of California Irvine, and Luc Bernard; 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](http://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](http://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.

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**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.
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 non-technical 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
August 1, 2015: Applications for Fulbright Postdoctoral Fellowships in Israel. See tinyurl.com/nzhcy61.
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) Alice T. Schafer Prize. See “Mathematics Opportunities” in this issue.
September 15, 2015: Nominations for Association for Women in Mathematics (AWM) Falconer Lectureship. 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, Wynnnewood, 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/moscow, 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.


October 1, 2015: Applications for AWM Travel Grants and Mathematics Education Research Travel Grants. See https://sites.google.com/site/awmmathprograms/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.


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.


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, Wynnnewood, 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/moscow, 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.

Contact Information for Mathematics Institutes

American Institute of Mathematics
600 E. Brokaw Road
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www.aimath.org

Stefan Banach International Mathematical Center
8 Sniadeckich 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
Room 103, TransCanada Pipelines
Pavilion
107 Tunnel Mountain Drive
Box 1020, Stn. 48
Banff AB T1L 1H5, Canada
Telephone: 403-763-6999
Fax: 403-763-6990
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www.birs.ca

Basque Center for Applied Mathematics (BCAM)
Alameda de Mazarredo 14
48009 Bilbao, Basque Country, Spain
Telephone: +34 946 567 842
Fax: +34 946 567 843
email: info@bcamath.org
www.bcamath.org

Center for Discrete Mathematics and Theoretical Computer Science (DIMACS)
CoRE Building, 4th Floor
Rutgers University
96 Frelinghuysen Road
Piscataway, NJ 08854-8018
Telephone: 848-445-5928
Fax: 732-445-5932
email: center-admin@dimacs.rutgers.edu
dimacs.rutgers.edu

Center for Scientific Computation and Mathematical Modeling (CSCAMM)
University of Maryland
4146 CSIC Building #406
Paint Branch Drive
College Park, MD 20742-3289
Telephone: 301-405-0652
Fax: 301-314-6674
email: info@cscamm.umd.edu
www.cscamm.umd.edu/

Centre International de Rencontres Mathématiques (CIRM)
163, avenue de Luminy, Case 916
F-13288 Marseille Cedex 09, France
Telephone: 33 04 91 83 30 00
Fax: 33 04 91 83 30 05
email: info@cirm.univ-mrs.fr
www.cirm.univ-mrs.fr

Centre for Mathematics and Its Applications (CMA)
Australian National University
Acton ACT 2601 Australia
Telephone: 61 2 6125 5111
www.anu.edu.au
Centre for Quantum Geometry of Moduli Spaces
Aarhus University
Ny Munkegade 118, Bldg. 1530
DK-8000 Aarhus C
Denmark
Telephone: 45 8715 5141
Fax: 45 8613 1769
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Centre de Recerca Matemàtica (CRM)
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08193 Bellaterra
Barcelona, Spain
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www.crm.cat

Centre de Recherches Mathématiques (CRM)
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www.nim.nankai.edu.cn/nim_e/index.htm

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www.cmi.ac.in

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www.nim.nankai.edu.cn/nim_e/index.htm

Euler International Mathematical Institute
nab. Fontanki, 27
St. Petersburg 191023 Russia
Telephone: 7 960 279 10 37
Fax: 7 812 234 05 74
email: admin@euler.pdmi.ras.ru
www.pdmi.ras.ru/EIMI/index.html

Fields Institute for Research in Mathematical Sciences
222 College Street, 2nd Floor
Toronto, Ontario M5T 3J1 Canada
Telephone: 416-348-9710
Fax: 416-348-9714
email: inquiries@fields.utoronto.ca
www.fields.utoronto.ca/

Institut Henri Poincaré
11, rue Pierre et Marie Curie
75231 Paris Cedex 05, France
Telephone: 33 01 44 27 64 88
email: com@ihp.fr
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Institut Mittag-Leffler
Auravägen 17
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email: info@mittag-leffler.se
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Institute for Advanced Study (IAS)
School of Mathematics
Simonyi Hall
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Telephone: 609-734-8100
Fax: 609-951-4459
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Institute for Computational and Experimental Research (ICERM)
Brown University
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Providence, RI 02912
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Institut des Hautes Études Scientifiques (IHES)
Le Bois Marie 35, route de Chartres
F 91440 Bures sur Yvette, France
Telephone: 33 1 60 92 66 00
Fax: 33 1 60 92 66 69
email: dir@ihes.fr
www.ihes.fr

Institute for Mathematics and its Applications (IMA)
University of Minnesota
College of Science and Engineering
306 Lind Hall
**Reference and Book List**

**Statistical and Applied Mathematical Sciences Institute (SAMSI)**
19 T. W. Alexander Drive
P.O. Box 14006
Research Triangle Park, NC 27709-4006
Telephone: 919-685-9350
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email: info@samsi.info
www.samsi.info/

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**Steklov Institute of Mathematics**
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**Tata Institute of Fundamental Research**
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**Warwick Mathematics Research Centre**
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**Weierstrass Institute for Applied Analysis and Stochastics**
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email: contact@wias-berlin.de
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.


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Moving?

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(401) 455-4000 (Worldwide)
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: wwf.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/isoc2015

*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 pensils 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,** Bonnie Bay Marine Station of Memorial University of Newfoundland in Norris Point, 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

  **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**

  **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

  **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

  **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 $q$-analogue, 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 under-represented 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 Mechaik (Canada), J.-M. Bonnisseau (France), Alain Chatelaine (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 (schebbi@ksu.edu.sa).
Information: npst.ksu.edu.sa/en/iceomfe/about

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 (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
- 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/

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/
Mathematics Calendar


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 Luisa 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 Luisa 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/


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


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:
- 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 700010, 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 contributed 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.


Information: calcuttastatisticalassociation.org/triennial/symp-Brochure.php

February 2016


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.f111.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.


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/repstability

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; Prüfer 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), Mátéy Dömokos (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 $\Pi^\perp_{\text{alg}}(\text{PGL}_n)$ for $n \leq 5$; Description of $\Pi^\text{disc}_{\text{alg}}(\text{SO}_7)$ and $\Pi^\text{disc}_{\text{alg}}(\text{PGL}_6)$; Description of $\Pi^\text{disc}_{\text{alg}}(\text{SO}_9)$ and $\Pi^\text{disc}_{\text{alg}}(\text{PGL}_8)$; Description of $\Pi^\text{disc}_{\text{alg}}(\text{G}_2)$; 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 $\text{SO}_{25}$ with trivial coefficients; Bibliography.

Memoirs of the American Mathematical Society, Volume 237, Number 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

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

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

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 multisémiotic 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.

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


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 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


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

**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


**Differential Equations**

**Nonlinear Dynamics in Partial Differential Equations**


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](http://www.ams.org/bookstore).

EMS Tracts in Mathematics, Volume 24


**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.

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
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](http://www.ams.org/bookstore).

IRMA Lectures in Mathematics and Theoretical Physics, Volume 21


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
**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](http://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/](http://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](http://occampress.com).

I will welcome reader comments.

—Peter Schorer

peteschorer@gmail.com

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**NOTICES OF THE AMS**

**August 2015**

**Classified Advertisements**

*Positions available, items for sale, services available, and more*

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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.


**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.
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

www.ams.org/featurecolumn
Meetings & Conferences of the AMS

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 (Erdos 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.
Meetings & Conferences

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 (Terry) Choi, NORC at the University of Chicago, and Illinois Institute of Technology.


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 Szanislo, 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 Algebra Combinatorics (Code: SS 6A), Marcelo Aguiar, Cornell University, and Aaron Lauve, Loyola University Chicago.

K-loops, Nearrings, 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, University of Wisconsin-Madison.

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.


Model Theory (Code: SS 15A), Uri Andrews, University of Wisconsin-Madison, Isaac Goldring, 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 Conrad, 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), Rafał 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/sectional1.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.
- 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), Gisèle 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.
- 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.
- 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 #114
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.
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 Niki, 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/sectional1.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/laxf1-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 3.8 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. 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.

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 September 30, 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 3 miles 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 non-smoking 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.


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
communicate your needs in advance to the AMS Meetings Department by:
- Registering early for the meeting
- Checking the appropriate box on the registration form
- Sending an email request to the AMS Meetings Department at mmsb@ams.org or meet@ams.org.

Other Activities

Book Sales: Stop by the on-site AMS bookstore to review our newest publications and take advantage of exhibit discounts! AMS members receive 40% off list price. Nonmembers receive a 25% discount. Not a member? Ask 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 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.ocairport.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:

* 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 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

Announcement: Steven H. Weintraub

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 Drelsich, 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 Ivic 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 Rizzo, 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 Susan, Medgar Evers College, City University of New York.
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), will be announced.

January 6–9, 2016

Wednesday – Saturday

Seattle, Washington

Washington State Convention Center and the Sheraton Seattle Hotel

Meetings & Conferences

Representations of Reductive Groups (Code: SS 11A), Jeffrey Adams, University of Maryland, Stephen D. Miller, Rutgers University, and David Vogan, Massachusetts Institute of Technology.


Topological Data Analysis: Computations, Statistics, and Applications (Code: SS 18A), Miroslav Kramar and Rachel Levanger, Rutgers University.

AMS Invited Addresses

Alex Eskin, University of Chicago, The SL(2, 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 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), Paweł 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).


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 Williams, University of Arizona, Tucson.

Fractal Geometry and Dynamical Systems (Code: SS 13A), John Rock, Cal Poly Pomona, Michiel van Frankenhuysen, 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 Pevzner, 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, 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).

Integral 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.


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.


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 Society for the Promotion of Science, Salvador E. Venegas-Andraca, Tecnologico de Monterrey, Mexico, and Nelson Petulante, Bowie State University.

Random and Complex Dynamics of Reaction-Diffusion Systems (Code: SS 27A), Michael Anton Hoegerle, 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 Postdocs of the Alliance for Diversity in Mathematics (Code: SS 53A), Aloyisius 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, Gremley, 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. Khan, Rochester Institute of Technology, Mau Nam Nguyen, Portland State University, Miguel Sama, Universidad Nacional de Educacion a Distancia, Spain, and Chrsitiane Tammmer, 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, Carleton College.

Water Waves (Code: SS 21A), John Carter, Seattle University, Bernard Deconinck, University of Washington, Seattle, and Katie Olveras, 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 Debroah 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

**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](http://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](http://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

**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](http://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 Gomez, 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), Álvaro 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
Ricardo Cortez, Tulane 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).
Meetings & Conferences

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

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).

Deadlines
For organizers: To be announced
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
Meetings & Conferences

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

As part of the Society’s commitment to the open flow of communication and community engagement, the AMS uses several networking tools to supplement the channels currently in place for members, press and the general public.

We invite you to share AMS website content and set up RSS feeds for website updates and blogs.

www.ams.org/social
Meetings and Conferences of the AMS

Associate Secretaries of the AMS

Central Section: Georgia Benkart, University of Wisconsin-Madison, Department of Mathematics, 480 Lincoln Drive, Madison, WI 53706-1388; e-mail: benkart@math.wisc.edu; telephone: 608-263-4283.

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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    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  p. 869
March 10–12    Charleston, South Carolina p. 870

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/)
Your gift to AMS Graduate Student Chapters enables essential programming for graduate mathematics students. Each chapter receives $500 a year with which they can fund programming to suit their needs, such as guest speakers, forums in related disciplines and more.

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Summer Reading Sale

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

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$49; AMS members US$39.20; Order code MBK/93

Olli Lehto, University of Helsinki, Finland

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.

Lars Ahlfors — At the Summit of Mathematics
Translated by William Hellberg

Reuben Hersch, University of New Mexico, Albuquerque, NM

Reuben Hersch, 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.

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.

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.

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.

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.

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
A book about the life of Peter Lax, one of the most famous and influential mathematicians of the modern era.

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