

**Summer Research for Women in Mathematics 2018**

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## **A. Introduction**

The MSRI project, Summer Research for Women in Mathematics (SWiM) is part of MSRI's overall activities aimed at strengthening the mathematical sciences by facilitating research and professional activities leading to or enhancing successful, productive careers. As part of this goal, it is important to recognize that for some populations inequities exist and need to be redressed. For some, a remedy is to increase the visibility and impact of their research, for others it is to increase their productivity. This program has been aimed at creating a rewarding and collegial environment that furthers success, benefiting the mathematical community at large. Responses to the exit survey reveal that the program was successful in working toward this goal; when asked about their level of professional satisfaction with MSRI, 100% of respondents gave a rating of 5 out of 5. MSRI is gratified to see that respondents also gave a unanimous 5 out of 5 rating to the administrative support they received

The present grant provided space and funds for 6 groups of women researchers to work on a research project for two or three weeks at MSRI during the summer of 2018. Each group was comprised of between 2 and 5 researchers, with a total of 20 women participating overall (one of whom was part of two separate groups). These were research projects that had already been started, perhaps at a conference such as Women in Topology, Women in Numbers or could be freestanding activities.

The groups were asked to provide bio sketches, a brief history of the collaboration, the context and description of the research problems to be addressed, partial results already obtained, realistic goals to be achieved during the residence at MSRI, and plans for research that will occur before, during and after their stay at MSRI.

Factors in choosing the groups included: scientific merit of the project, the likelihood of finishing the project within the timeline specified in the application, and the extent to which this opportunity will enhance the project, for example by bringing together researchers from different institutions.

## **D. & E. Description of Conference Activities & Publications**

Each research group worked on the projects outlined in their proposal. They met daily at MSRI, and many met in the evenings and weekends at the apartments reserved for them on the campus of UC Berkeley. The groups have continued to meet virtually to further their research.

The following status updates have been provided to MSRI:

### **Daugherty, Halacheva, Im and Norton (5/14/19)**

We (Daugherty, Halacheva, Im, and Norton) have studied calibrated and some general indecomposable representations of the rank 2 affine periplectic Brauer algebra  $sV_2$ , which is also known as degenerate affine Brauer superalgebra in the literature. This algebra is an enhancement of the rank 2 degenerate affine Hecke algebra by a Temperley-Lieb type generator  $e$  which squares to 0.

An  $m$ -dimensional module  $V = C\{v_1, \dots, v_m\}$  is called calibrated if the  $v_j$  are simultaneous eigenvectors for all the elements of a maximal commutative subalgebra. In the case studied, this is a polynomial algebra in two variables. We have classified finite-dimensional indecomposable calibrated representations of  $sV_2$  when the generator  $e$  acts nontrivially (those when  $e$  acts by 0 factor through the degenerate affine Hecke algebra and are already classified) and when the eigenvalues are generic. We found that the condition to determine when a calibrated representation is indecomposable can then be described using what we nickname rhizomatic matrices, which are matrices where the nonzero entries “connect all the rows and columns.” An indecomposable representation obtained in this way has the property that it is an extension of two direct sums of 1-dimensional representations.

We have also studied noncalibrated indecomposable representations of  $sV_2$  when one of the polynomial generators is represented by a single Jordan block. An interesting fact about these representations is that the generator  $e$  always acts by 0, and therefore all such representations factor through the degenerate affine Hecke algebra. We suspect that we may then build interesting extensions of two direct sums of such 1-Jordan block representations in an analogous way to how we built generic calibrated representations as extensions of two direct sums of 1-dimensional representations.

Our paper has been posted on the arXiv (<https://arxiv.org/abs/1905.05148>) and has been submitted to a journal.

### **Fefferman, Price, Sindi, Williams, Wilson (5/6/19)**

Since MSRI our group has continued our weekly virtual research meetings. We have made considerable progress on 3 manuscripts that are a direct result of the MSRI program. As we develop these manuscripts for submission we suspect that we will submit to a mix of more applied and more fundamental mathematical journals. We will absolutely keep you posted when our work is published. Moreover, our continued collaboration has resulted in ongoing plans for NSF proposals.

Manuscripts:

Parasites, Pathogens, and the Evolution of Sociality: How Modes of Infection Alter the Selective Pressures on Group Organization

Do Increasingly Complex Social Systems Require Increasingly Efficient Allogrooming to Mitigate the Risk of Parasitic Outbreaks?

Does Grooming in Dominance Hierarchies Just Benefit those at the Top?

I am also pleased to announce that Nakeya Williams, who at the time of our visit to MSRI was in a postdoctoral position at West Point recently accepted a tenure-track faculty position at the US Merchant Marine Academy in Kings Point, NY to start in July, 2019. As she was the only member of our team not in a permanent faculty position we are all very excited for her.

### **Gordon, Mainkar, Payne, Will (5/6/19)**

We've made progress [and] as explained below, [due to] some unanticipated twists and turns we do not yet have a paper to report.

Working together intensely for two weeks at MSRI enabled us to advance our research project to the point that we could work together more effectively long distance. We have continued to hold regular meetings through google hangout. Three members of our team reunited in March in Idaho while the fourth joined in virtually from Argentina.

Our original conjecture on almost inner derivations of two-step nilpotent Lie algebras proved to be more complex than anticipated. In fact, we have constructed an interesting counterexample to the conjecture in its full generality while also proving the conjecture in some special cases. We continue to work on proving the conjecture in the setting most relevant to the geometric question of rigidity of geodesic flows on nilmanifolds. Our work on the conjecture has led to some unanticipated consequences for the structure of two-step nilpotent Lie algebras; we will continue to follow this new thread as well.

### **Daugherty, Hicks, Mason, Niese (5/6/19)**

This is very much an ongoing project, which we will be actively meeting on in summer 2019. We don't currently have a publication to report, though we're hopeful we'll be there by the end of this summer.

Manuscript: Quasisymmetric Macdonald Polynomials and Their Relationship to the Double Affine Hecke Algebra

## **Escher, Searle (5/7/19)**

The paper we worked on last year at MSRI has been posted on the arxiv (arxiv:1811.01493), and we are in the midst of some final editing before submitting it, hopefully during the week of May 20th.

## **Aceska, Kim (5/6/19)**

We are finalizing our draft of the proposed paper. By the end of this July, we think that we will be able to submit our manuscript. We will definitely inform you when we are submitting the work.

Manuscript: Evolutionary systems representations based on later time samples and applications to PDEs

## **F. Conclusion**

This program has been and continues to be a success. A selection of comments from the exit interviews shows the impact that this has had on the Summer 2018 participants:

*"I had the opportunity to completely immerse myself in the project, thinking about it and nothing else for two weeks, without the distractions (social, work, domestic) I have at home. We were pretty stuck at the start, and there were certain snags I had to come back to over and over and over until things finally became clear to me. I also got to know two of my collaborators better personally which I think is beneficial in terms of comfort, trust, willingness to ask stupid questions, etc."*

*"In addition to working on the research that we wrote about in our proposal, we were able to advance several new lines of research and outline future grant proposals. This was far more than I imagined would have been possible during such a short time span and shows the power of everyone being in the same place."*

*"While many aspects were beneficial, the most valuable one was the insulated and supportive environment. While visiting, my colleagues and I could ignore all external concerns and focus uniquely on the mathematics research. If we needed anything from food to computational resources, they were provided and the staff was amazingly friendly and helpful."*

*"There were surprising and profound differences working in an all-female group. The biggest was that I did not feel challenged in my right to have research opinions. If I was wrong, we moved on, if I was right, it wasn't vindication for my own contribution, it was all of us moving forward. It made the entire endeavor more relaxed and collaborative and productive for me than my other collaborative experiences."*

*"I think this is a wonderful program. There are now many workshops designed to help women form collaborations with each other. The opportunity to come together to continue their research collaborations is very valuable."*

All groups are working on manuscripts for publication, some of which have already been submitted for publication. The success of this program has convinced MSRI to continue SWiM in the summer of 2019 (with plans for the future as well). Forty-six groups in diverse fields (comprised of 153 women) applied for the 2019 program, up from 22 groups and 81 women who applied for the 2018 program. Thanks to grants from the National Security Agency and private foundations, we have been able to extend offers to 13 groups (46 women) for two-week visits during the summer, more than doubling the number of 2018 participants.