

# The 69th Meeting of the Alabama Association of College Teachers of Mathematics

Huntingdon College, Montgomery, AL  
March 2, 2019

## The 2019 Lewis-Parker Lecture

*The Spider and the Fly*

Cornelius Pillen, University of South Alabama

### ABSTRACT

Then I said my, my, like a spider to a fly.  
Jump right ahead in my web.  
- Mick Jagger, Keith Richards

The spider and the fly are sitting in the coordinate plane. The spiders coordinates are  $(2018, 6903)$  and the fly sits at  $(2561, 2353)$ . The spider is no ordinary spider. It discreetly spins its web by moving in four different directions. Starting from the point  $(a,b)$ , the spider can jump to  $(a+b, b)$ ,  $(a-b, b)$ ,  $(a, b+a)$ , or  $(a, b-a)$ . The fly is terrified and sits perfectly still. Will the spider ever catch the fly?

After we present and represent the Spider Group we look at the spider's orbit and count the prime locations. Finally, the spider's moves appear in a surprising connection to modular representation theory of algebraic groups.

## Alabama Journal of Mathematics

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The Alabama Journal of Mathematics is published under the auspices of the Alabama Council of Teachers of Mathematics (ACTM) and the Alabama Association of College Teachers of Mathematics (AACTM). The AJM is designed to meet a number of needs of the mathematics community in the State of Alabama. Specifically, the intent of the Journal is to knit together the various components of this mathematical community. As such, the journal includes research articles in mathematics and mathematics education appropriate for a general audience and activities and problems for K-16 mathematics teachers.

## Acknowledgements

The AACTM would particularly like to thank Huntingdon College for graciously hosting this year's conference and Anneliese Spaeth and William Young for their very hard and diligent work as the local organizers.

Thank you so much for your efforts to make this conference a success.

### AACTM Officers

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## AACTM SCHEDULE

<b>8:15am–9:00am</b>	Registration
<b>9:00am–9:10am</b>	Welcome
<b>9:10am–9:25am</b>	<b>Joel Henningsen and Dr. Armin Straub</b> , University of South Alabama <i>Sequences Modulo Primes and Finite State Automata</i>
<b>9:30am–9:45am</b>	<b>Dr. Kelly Guest and Dr. Li Huang</b> , Tuskegee University <i>Personal Data versus Teacher Selected Data Tasks in Pre-Calculus: Preliminary Results</i>
<b>9:50am–10:05am</b>	<b>Jörg Feldvoss</b> , University of South Alabama <i>Pythagorean Triples and Complex Numbers</i>
<b>10:10am–10:25am</b>	<b>Trung Hoa Dinh</b> , Troy University <i>Majorization theory and matrix inequalities</i>
<b>10:25am–10:45am</b>	Break
<b>10:45am–11:45am</b>	<b>LEWIS-PARKER LECTURE</b> <b>Cornelius Pillen</b> , University of South Alabama <i>The Spider and the Fly</i>
<b>11:45am–1:00pm</b>	Lunch
<b>1:00pm–1:15pm</b>	<b>Andrei Pavelescu</b> , University of South Alabama <i>Escher squares and lattice links</i>
<b>1:20pm–1:35pm</b>	<b>Eze R. Nwaeze</b> , Tuskegee University <i>New inequalities for <math>\eta</math>-quasiconvex functions</i>
<b>1:40pm–1:55pm</b>	<b>Dr. Christopher Lin</b> , University of South Alabama <i>Gibbs entropy of symmetric operators</i>
<b>2:00pm–2:15pm</b>	<b>Alex T. Leveque and Pat Rossi</b> , Troy University <i>Limit Points Without Limit – Construction Problems Proposed and Solved by an Undergraduate Student</i>
<b>2:20pm–2:35pm</b>	<b>Dr. Vasilii Prokhorov</b> , University of South Alabama <i>The Mobile Math Circle</i>
<b>2:40pm–3:10pm</b>	Panel Discussion on <u>The Changing Student Mindset</u>
<b>3:10pm–3:20pm</b>	Break
<b>3:20pm</b>	Business meeting

## ABSTRACTS

(in alphabetical order by speaker's name)

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### Trung Hoa Dinh

Troy University

*Majorization theory and matrix inequalities*

In this talk we discuss about majorization theory and some applications in matrix inequalities. We also introduce some suitable topics for undergraduate research beyond Linear Algebra.

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### Jörg Feldvoss

University of South Alabama

*Pythagorean Triples and Complex Numbers*

The parametrization of Pythagorean triples is well known. Either this result is obtained arithmetically by factorization of polynomials and applying divisibility properties of integers or geometrically by projection from the unit circle with a fixed prescribed point. In my talk I will explain how the parametrization of Pythagorean triples can also be obtained by using the algebra of complex numbers. I will present two different proofs – one being inspired by a proof due to Olga Taussky using trigonometric identities and another one being a consequence of a very special case of Hilbert's Theorem 90. Both proofs provide a purely algebraic approach to the parametrization of Pythagorean triples. It also turns out that the needed special case of Hilbert's Theorem 90 is equivalent to the parametrization of Pythagorean triples. The connection between Pythagorean triples and Hilbert's Theorem 90 seems to have been observed for the first time by Olga Taussky and has been discovered again about ten years ago by Noam Elkies.

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### Dr. Kelly Guest and Dr. Li Huang

Tuskegee University

*Personal Data versus Teacher Selected Data Tasks in Pre-Calculus: Preliminary Results*

We will share preliminary results from a National Science Foundation (NSF) Funded Improving Undergraduate STEM Education (IUSE) implementation in Pre-Calculus courses at one 4-year and two 2-year institutions. Tasks were assigned to two treatment groups, one in which students freely chose personal contexts for their data and one in which the context of the data was restricted by the teacher. Pre and post tests were aligned with the mathematical topics of the tasks as well as other topics. Copies of student work were qualitatively analyzed. Participants will gain insight into our experiences assigning two tasks, one addressing the definition of a function and the other addressing the connection of polynomial function equations with their graphs. Differences in results for the two treatment groups will be discussed as well as insight gained from student verbal responses in their work on the two tasks.

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### Joel Henningsen and Dr. Armin Straub

University of South Alabama

*Sequences Modulo Primes and Finite State Automata*

A sequence is  $k$ -automatic if its values  $a(n)$  are determined by a finite-memory function of the base- $k$  digits of  $n$ . Rowland and Zeilberger describe two algorithms to obtain, given a sequence as a constant term of powers of Laurent polynomials, the finite state automaton describing its values modulo a power of  $p$ . We discuss and analyze these algorithms, and consider examples that include the Catalan numbers, the Motzkin numbers and other famous combinatorial sequences. In particular, we make a conjecture on the number of states of some of the resulting recurrence schemes.

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### Alex T. Leveque and Pat Rossi

Troy University

*Limit Points Without Limit – Construction Problems Proposed and Solved by an Undergraduate Student*

The author presents a pair of construction problems in Real Analysis that he proposed to his professor and then subsequently solved on his own, using techniques learned in his Real Analysis course. The problems are: “Do there exist sequences that have infinitely many limit points?” and “Do there exist sequences that have uncountably many limit points?”

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**Dr. Christopher Lin**

University of South Alabama

*Gibbs entropy of symmetric operators*

The Gibbs (equilibrium) entropy is an important quantity in statistical mechanics describing disorder in a thermodynamic system. It has a well-defined mathematical formula based on the so-called “partition function”, which is computed from the energies of microstates of the system. We will borrow this formula and using some elementary linear algebra and Calculus, compute the Gibbs entropy associated with certain microstates defined by symmetric operators on a finite-dimensional inner-product space. The end result is related to special functions that one would see in applied mathematics. If time permits, we will discuss how the infinite-dimensional analog may be related to G. Perelman’s seminal work on the Ricci flow.

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**Eze R. Nwaeze**

Tuskegee University

*New inequalities for  $\eta$ -quasiconvex functions*

Recently, the class of  $\eta$ -quasiconvex functions was introduced. In this talk, I will discuss some novel inequalities of the Ostrowski type for functions whose second derivative, in absolute value raised to the power  $q \geq 1$ , is  $\eta$ -quasiconvex. Several interesting inequalities are deduced as special cases. Furthermore, some applications of our results to the arithmetic, geometric, Harmonic, logarithmic, generalized log and identric means are also presented.

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**Andrei Pavelescu**

University of South Alabama

*Escher squares and lattice links*

In this talk we present a shorter and simpler proof of the result of Allardice and Bloch, which gives a necessary and sufficient condition for a lattice diagram to be the projection of a lattice link.

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**Dr. Vasily Prokhorov**

University of South Alabama

*The Mobile Math Circle*

For twenty years a problem solving program called “The Mobile Math Circle” has been offered to secondary students from Mobile County. The students are instructed in a variety of problem-solving topics that they would not encounter in the usual high school mathematics curriculum. In this presentation we share our Math Circle teaching experience, effective topics, and presentation strategies with the AACTM attendees.