

The 65th Meeting of the Alabama Association of College Teachers of Mathematics

University of Alabama, Tuscaloosa, AL
February 7, 2015

The 2015 Lewis-Parker Lecture

When does a function belong to the union of Lebesgue spaces?

Kabe Moen, University of Alabama

ABSTRACT

We give a brief review of Lebesgue spaces and their uses in analysis. We show that Lebesgue spaces considered in aggregate are intimately related to the Hardy-Littlewood maximal function and the theory of weighted Lebesgue spaces – Lebesgue spaces with a change of measure. We give several simple characterizations of when a function belongs to the union of Lebesgue spaces in both local and global settings. This lecture will be based on joint work with Greg Knese and John McCarthy.

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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

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

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AACTM SCHEDULE

- 8:15–9:00** Registration
- 9:00–9:10** Welcome
- 9:10–9:25** **Stavros A. Belbas**, University of Alabama
Certain optimal control problems for systems with memory
- 9:30–9:45** **Jianzhen Liu**, Auburn University
Representations of deformed preprojective algebras and quantum groups
- 9:50–10:05** **Luke Smith**, Auburn University Montgomery
Encouraging students to explore word problems through non-algebraic means
- 10:10–10:25** **Tin-Yau Tam**, Auburn University
Geometric means for positive definite matrices and its generalization in symmetric spaces
- 10:25–10:45** Break
- 10:45–11:45** **LEWIS-PARKER LECTURE**
Kabe Moen, University of Alabama
When does a function belong to the union of Lebesgue spaces?
- 11:45–1:00** Lunch
- 1:00–1:15** **Thomas E. Leathrum**, Jacksonville State University
Personal finance as a practical approach to mathematical literacy
- 1:20–1:35** **Brandon Barry**, University of Alabama at Birmingham
Laminations
- 1:40–1:55** **John C. Mayer**, University of Alabama at Birmingham
Sibling Laminations, Central Strips, and Julia Sets
- 2:00–2:20** Panel Discussion on student projects
- 2:20–2:40** Break
- 2:40–2:55** **Zekeriya Y. Karatas**, Tuskegee University
Groups whose non-permutable subgroups satisfy certain conditions
- 3:00–3:15** **Regina Jackson**, Auburn University
Enriching online homework in precalculus courses with media
- 3:20–3:35** **Jerome Goddard II**, Auburn University Montgomery
Modeling the effects of habitat fragmentation via reaction diffusion equations
- 3:40** Business meeting

ABSTRACTS
(in alphabetic order by speaker surname)

Speaker: **Brandon Barry**, University of Alabama at Birmingham

Title: *Laminations*

Abstract: Complex numbers are just too “complex”. However, basic geometry and dynamics are not! We introduce and discuss a Lamination as a collection of chords in the unit disk which do not cross each other. A Lamination is a geometric object used to aid in understanding sets which exist in the complex plane. We also discuss Laminations as interesting objects in and of themselves.

Speaker: **Stavros A. Belbas**, University of Alabama

Title: *Certain optimal control problems for systems with memory*

Abstract: Classical control theory deals with systems governed by differential equations. For systems with memory, governed by integral equations, the corresponding optimal control problems pose interesting mathematical challenges. Such systems arise in biophysics, mathematical finance, sociophysics and econophysics, theory of viscoelasticity and other types of physical problems with constitutive laws with memory, and other areas. In this talk, I will outline the similarities and the differences between control with memory effects and classical control. The talk is based in part on some of my recent publications. The talk will be suitable for general mathematical audience.

Speaker: **Jerome Goddard II**, Auburn University Montgomery

Title: *Modeling the effects of habitat fragmentation via reaction diffusion equations*

Abstract: Two important aspects of habitat fragmentation are the size of fragmented patches of preferred habitat and the inferior habitat surrounding the patches, called the matrix. Ecological field studies have indicated that an organism’s survival in a patch is often linked to both the size of the patch and the quality of its surrounding matrix. In this talk, we will focus on modeling the effects of habitat fragmentation via the reaction diffusion framework. First, we will introduce the reaction diffusion framework and a specific reaction diffusion model with logistic growth and Robin boundary condition (which will model the negative effects of the patch matrix). Second, we will explore the dynamics of the model via the well-known quadrature method and ultimately obtain a causal relationship between the size of the patch and the quality of the matrix versus the maximum population density sustainable by that patch.

Speaker: **Regina Jackson**, Auburn University

Title: *Enriching online homework in precalculus courses with media*

Abstract: In recent years, universities have turned to publisher based homework management systems to supplement Precalculus instruction. Though these systems include loads of resources, students do not take advantage of them. By making these resources available in the homework, we can encourage the students to utilize them. The presentation will focus on how tutorials, applets, videos, and other resources can be constructed using tools such as Geogebra and how they can be included in Enhanced WebAssign and Canvas, the two learning management systems used by Auburn University.

Speaker: **Zekeriya Y. Karatas**, Tuskegee University

Title: *Groups whose non-permutable subgroups satisfy certain conditions*

Abstract: In this talk, I will give the structure of groups with all subgroups permutable or of finite rank. Our main result states that an infinite rank \mathfrak{X} -group with all proper subgroups permutable or of finite rank has all subgroups permutable. Hence, such groups are metabelian. Before giving our main result, I will give the definitions, well-known results and some history about the concept.

Speaker: **Thomas E. Leathrum**, Jacksonville State University

Title: *Personal finance as a practical approach to mathematical literacy*

Abstract: We have been working at JSU to provide students not pursuing majors in a STEM discipline with alternatives to the Precalculus sequence courses. Textbooks for both Finite Mathematics and a broader survey course we call “Exploring Mathematics” include a chapter on mathematics of finance with topics such as compound interest and annuities, useful for students but often out of context for these courses. Another department approached us saying their students need a course covering practical uses of percentages for

marketing and finance, but with an emphasis on applications relevant to consumers or employees rather than business or management. Seeing an opportunity to both address this request and allow the other courses to better focus their material, we created a new course, MS106 Mathematics of Personal Finance. Applications covered include markups and markdowns, single and chain discounts, simple interest, revolving credit accounts, compound interest, annuities, installment loans and mortgages, amortization, and the costs of home ownership. The development of formulas for these applications involves some interesting mathematical tools such as exponentials and partial geometric sums. Finding an appropriate textbook has been problematic, so we have begun developing custom materials. The course has been slow to catch on with students and difficult to advertise with other departments (problems shared with the other courses), but we feel it has great potential to provide students with mathematical skills which they will find useful after college.

Speaker: **Jianzhen Liu**, Auburn University

Title: *Representations of deformed preprojective algebras and quantum groups*

Abstract: Let (Γ, I) be the bound quiver of a cyclic whose vertices correspond to the Abelian group \mathbb{Z}_d . We list all indecomposable representations of (Γ, I) and give the conditions that those representations of them can be extended to representations of deformed preprojective algebra $\Pi^\lambda(\Gamma, I)$. It is shown that those representations given by extending indecomposable representations of (Γ, I) are all simple representations of $\Pi^\lambda(\Gamma, I)$. Therefore, it is concluded that all simple representations of restricted quantum group $\overline{U}_q(\mathfrak{sl}_2)$ are realized in terms of deformed preprojective algebra.

Speaker: **John C. Mayer**, University of Alabama at Birmingham

Title: *Sibling Laminations, Central Strips, and Julia Sets*

Abstract: Quadratic laminations of the unit disk were introduced by Thurston as a vehicle for understanding the (connected) Julia sets of quadratic polynomials and the parameter space of quadratic polynomials. The “Central Strip Lemma” plays a key role in Thurston’s classification of gaps in quadratic laminations, and in describing the corresponding parameter space. We generalize the notion of *Central Strip* to laminations of all degrees $d \geq 2$ and prove a Central Strip Lemma for degree $d \geq 2$. We show some examples of its application in degree $d = 3$.

Speaker: **Luke Smith**, Auburn University Montgomery

Title: *Encouraging students to explore word problems through non-algebraic means*

Abstract: My presentation would report findings from an experimental study that addressed two different teaching paradigms that were used in postsecondary remedial mathematics courses. In this study, one group of students was taught by first developing students’ procedural skills (i.e. algebraic techniques and algorithms) before later showing them how to apply those skills to solve application problems (i.e. word problems). Students in the other group were taught by first introducing them to realistic or intriguing application problems and encouraging to find solutions through non-algebraic means (such as pictures, tables, and graphs); after students had time to explore the application problems, the procedural skills related to those problems were subsequently introduced and developed in the context of the proposed application problems. This study found that students in the former group demonstrated a strong positive correlation ($r = 0.77$) between their scores on their application problems and their scores on procedural problems; more specifically, their procedural abilities tended to limit their abilities to solve application problems. In contrast, students in the latter group demonstrated a much weaker positive correlation ($r = 0.23$) between their application scores and their procedural scores; these students were more likely to earn scores on their application problems that were much higher than their scores on procedural problems. This difference in correlations was statistically significant and may be due to the fact that the group of students who learned to use non-algebraic techniques possessed additional techniques at their disposal to solve application problems.

Speaker: **Tin-Yau Tam**, Auburn University

Title: *Geometric means for positive definite matrices and its generalization in symmetric spaces*

Abstract: We discuss the notion of geometric means of two positive definite matrices. The geodesic result of Bhatia and Holbrook (2006) and the triangle result of Bhatia (2003) are extended in the context of symmetric spaces. Based on a joint work with Ming Liao and Xuhua (Roy) Liu.