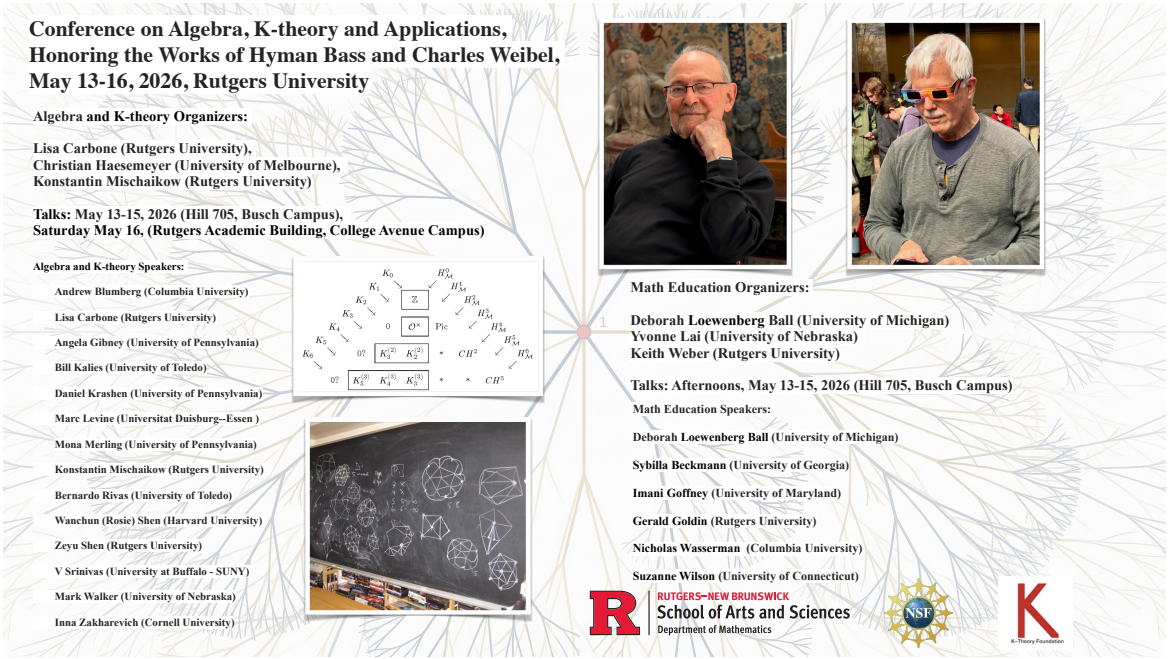
Conference on Algebra, K-theory and Applications, Honoring the Works of Hyman Bass and Charles Weibel, May 13-16, Rutgers University



Algebra and K-theory Organizers: Lisa Carbone (Rutgers), Christian Haesemeyer (University of Melbourne), Konstantin Mischaikov (Rutgers)

Algebra and K-theory Talks: Wednesday May 13, Thursday May 14, Friday May 15 (Hill Center, Busch Campus) Saturday May 16, (Rutgers Academic Building, College Avenue Campus)

Math Education Organizers: Deborah Loewenberg Ball (University of Michigan), Yvonne Lai (University of Nebraska) and Keith Weber (Rutgers University)

Math Education talks: Afternoons, May 13, May 14, May 15 (Hill Center, Busch Campus)

Conference Schedule

Wednesday May 13 Hill Center 705, Busch Campus

8.30 am - 9.00 am: Coffee and breakfast in Hill 703
9.00 am - 9.50 am: Mark Walker (University of Nebraska)
10.00 am - 10.50 am: Angela Gibney (University of Pennsylvania)
11.00 am - 11.30 am: Coffee in Hill 703
11.30 am - 12.30 pm: Daniel Krashen (University of Pennsylvania)
12.30 pm - 2.00 pm: Lunch
2.00 pm - 2.50 pm: Deborah Loewenberg Ball (University of Michigan)
3.00 pm: Coffee in Hill 703
3.30 pm: Suzanne Wilson (University of Connecticut)
4.30 pm: Finish

Thursday May 14, Hill Center 705, Busch Campus

8.30 am - 9.00 am: Coffee and breakfast in Hill 703
9.00 am - 9.50 am: Konstantin Mischaikow (Rutgers University)
10.00 am - 10.50 am: Bill Kalies (University of Toledo)
11.00 am - 11.30 am: Coffee in Hill 703
11.30 am - 12.30 pm: Bernardo Rivas (University of Toledo)
12.30 pm - 2.00 pm: Lunch
2.00 pm - 2.50 pm: Imani Goffney (University of Maryland)
3.00 pm: Coffee in Hill 703
3.30 pm: Gerald Goldin (Rutgers University)
4.30 pm: Finish
5.30 pm:

Friday May 15, Hill Center 705, Busch Campus

8.30 am - 9.00 am: Coffee and breakfast in Hill 703
9.00 am - 9.50 am: Lisa Carbone (Rutgers University)
10.00 am - 10.50 am: Marc Levine (Universität Duisburg–Essen)
11.00 am - 11.30 am: Coffee in Hill 703
11.30 am - 12.30 pm: Mona Merling (University of Pennsylvania)
12.30 pm - 2.00 pm: Lunch
2.00 pm - 2.50 pm: Sybilla Beckmann (University of Georgia)
3.00 pm: Coffee in Hill 703
3.30 pm: Nicholas Wasserman (Columbia University)
4.30 pm: Finish

Saturday May 16, (Rutgers Academic Building, East Wing, Room 4225, College Avenue Campus, 15 Seminary Place, New Brunswick, NJ 08901)

8.30 am - 9.00 am: Coffee and breakfast in Hill 703
9.00 am - 9.50 am: Wanchun (Rosie) Shen (Harvard University)
10.00 am - 10.50 am: V Srinivas (University at Albany, SUNY)
11.00 am - 11.30 am: Coffee in Hill 703
11.30 am - 12.30 pm: Inna Zakharevich (Cornell University)
12.30 pm - 2.00 pm: Lunch
2.00 pm - 2.50 pm: Zeyu Shen (Rutgers University)
3.00 pm: Coffee in Hill 703
3.30 pm: Andrew Blumberg (Columbia University)
4.30 pm: Finish

Math abstracts

Speaker: Andrew Blumberg
Title: Towards the Kummer-Vandiver conjecture
Abstract: I will describe joint work with Mandell on a program to attack the Kummer-Vandiver conjecture using a new formulation in terms of trace methods and Iwasawa theory.

Speaker: Lisa Carbone
Title: How Steinberg groups appear in infinite dimensions
Abstract: We discuss how Steinberg groups appear in the construction of groups for infinite dimensional Lie algebras, namely a Lie group analog for the Monster Lie algebra.

Speaker: Angela Gibney
Title: Vector bundles on moduli of curves from representations of vertex algebras
Abstract: The moduli space of curves offers a natural setting for studying smooth curves and their degenerations. These spaces are connected through tautological maps that reflect their recursive nature. Many useful algebraic constructions associated with these spaces are functorial with respect to such maps. One particularly rich source of such structures comes from vector bundles of coinvariants and their duals, vector bundles of conformal blocks, defined via representations of vertex operator algebras. In my talk I will give a snapshot of our program (with Chiara Damiolini, Danny Krashen, and Nicola Tarasca), extending foundational results about these in low-genus, and for particular examples, to all genera and for a broad class of VOAs. I'll focus on a key tool known as the mode transition algebra, describing a new criterion for rationality. I will also discuss some applications from the work of my students.

Speaker: Bill Kalies
Title: Algebraic Approaches to Bifurcation and Composition of Dynamical Systems
Abstract: The global structure of a dynamical system can be represented in terms of bounded, distributive lattices and homomorphisms which are dynamically defined. These structures and their order-theoretic duals allow for the development of both new theoretical results and algorithmic approaches for the analysis of bifurcation and composition.

Speaker: Danny Krashen
Title: Algebraic perspectives on modules over vertex operator algebras
Abstract: Vertex operator algebras give rise to a plethora of algebraic structures that reflect various aspects of their representation theory. In this talk, I'll give a brief introduction to vertex operator algebras and their modules, and then will discuss joint work with Chiara Damiolini and Angela Gibney where we give different perspectives on certain categories of modules over a vertex operator algebra by relating them to modules over various associative algebras: universal enveloping algebras, Zhu algebras, mode transition algebras, and a series of new "zig-zag algebras," which we define. In doing so, we find new contexts in which the module theory may be completely described in terms of the Zhu algebra, and refine our understanding of the behavior of module categories in the non-rational case.

Speaker: Marc Levine
Title: 0-cycles on singular varieties
Abstract: In a paper (Crelle, 1985) with Chuck Weibel, we defined a group of relative 0-cycles $CH_0(X, Y)$. Taking Y to be the singular locus of X, this gives a definition of 0-cycles on a singular variety X, which admits a map to $K_0(X)$ if X is reduced. The quest for a good construction of cycles mod "rational equivalence" with a good relation to algebraic K-theory has continued up to the present day, with many different viewpoints and results. We will give an overview of some of these constructions and applications.

Speaker: Mona Merling
Title: Scissors congruence K-theory of manifolds and cobordism categories
Abstract: The scissors congruence K-theory of manifolds is a categorification of the SK (German "schneiden und kleben," cut and paste) groups for manifolds and it is the source of a derived Euler characteristic map. I will discuss the relationship of the scissors congruence K-theory of manifolds with the cobordism category and classical algebraic K-theory of spaces. This is joint work with George Raptis and Julia Semikina.

Speaker: Konstantin Mischaikov
Title: Developing a Framework for Homological Dynamics
Abstract: I will motivate this talk by explaining why in an era of computational and data driven dynamics there are serious challenges to using traditional methods for understanding nonlinear dynamics. I will then outline an alternative algebraic framework based on poset graded chain complexes with field coefficients. I will conclude with a discussion of future directions.

Speaker: Bernardo Rivas
Title: Conley complexes of gene regulatory networks
Abstract: For a gene regulatory network, we can represent the parameter space as a finite parameter graph. To each parameter node, we can assign a Conley complex, a P-graded chain complex encoding recurrent dynamics, computed from a wall labeling on a cubical cell complex. In this setting, adjacent parameter nodes yield chain maps between Conley complexes, recording bifurcations algebraically. I will describe this assignment and dynamical correspondence, and report on ongoing work on the continuation across DSGRN parameter space.

Speaker: Wanchun Shen
Title: Higher Singularities and Algebraic K-Theory
Abstract: Higher singularities are recent refinements of the classical notions of rational and Du Bois singularities. In this talk, I will give a gentle introduction to these singularities and explain some of their applications to algebraic K-theory.

Speaker: Zeyu Shen
Title: G-theory of simplicial toric varieties
Abstract: Algebraic G-theory of a Noetherian scheme is defined as the algebraic K-theory of coherent sheaves on the scheme. In this talk, I give several results on the computations of algebraic G-groups of simplicial toric varieties. For affine toric surfaces over an algebraically closed field of characteristic zero, all G-groups are computed. All G-groups of all weighted projective spaces over an arbitrary field are also computed. The lower G-groups of a product of two weighted projective spaces are also computed. The Grothendieck group of coherent sheaves of affine, simplicial toric varieties are studied using the Brown-Gersten-Quillen spectral sequence. A description in terms of the divisor class group is given in dimension 2. In dimension 3, I show that the Grothendieck group comes from a group extension of Chow groups. The order of the Chow group of codimension 1 cycles is computed for any affine, simplicial toric variety. And the Chow group of codimension 2 cycles is shown to vanish for smooth affine toric varieties, proving a special case of a conjecture of mine.

Speaker: V Srinivas
Title: Enriched Hodge structures and cycles on complex analytic thickenings
Abstract: This talk is a report on an ongoing project with Madhav Nori and Deepam Patel. We consider triples (X, A, B) where X is a complex analytic space, A, B are closed analytic subspaces such that A is a proper algebraic variety, and $X \setminus B$ is a complex manifold, and $A \setminus B$ is a submanifold. We view this as defining a representative of a germ of an analytic neighbourhood of A (the "thickening" of A). If $\iota : A \to X$ and $j : X \setminus B \to X$ are the inclusions, we may consider cohomology groups $H^m(A, \iota^{-1}Rj, \mathbb{Z})$ (and Tate twists). Our goal is to define a variant of Deligne-Beilinson cohomology for such objects, using Enriched Hodge structures (Bloch-Srinivas), which are "enhanced" versions of Mixed Hodge structures. We expect that our "Enriched D-B Cohomologies" would be the targets of regulators defined on suitable K-groups associated to such germs, and these would detect interesting elements in the K-theory of the germs. An example is when X is a small ball around $A = \{0\}$ in $\mathbb{C}^n$, and $B = \emptyset$, which corresponds to the K-groups of the ring of convergent power series in n complex variables; here the underlying MHS has no information, while the "enriched" version has content. In this talk, we will indicate how the EHS's are constructed, what the corresponding Enriched DB-cohomology looks like, and discuss some simple examples.

Speaker: Mark Walker
Title: Rank conjectures in algebra and topology
Abstract: This talk concerns conjectural lower bounds for Betti numbers arising in algebra and topology. In commutative algebra, Betti numbers are the ranks of the free modules appearing in a minimal free complex; in topology, they are the ranks of the homology groups of a space. Although these settings are quite different, several parallel rank conjectures predict lower bounds under natural hypotheses. For example, if a compact space admits a free action by a torus, its total Betti number is conjectured to be bounded below by the size of the acting torus. I will discuss the history and current status of these

conjectures, with particular attention to recent progress in characteristic two from joint work with Keller VandeBogert.

Speaker: Inna Zakharevich
Title: The K-theory of abelian monoid sets
Abstract: This is a talk about work on progress on the classification of the K-theory of monoid sets, following on work of Haesemeyer–Weibel. We will discuss a classification theorem for certain monoids, discuss difficulties that arise in the general case, and give plenty of examples. This is joint work with Mary Sarazola and Brandon Shapiro.

Math education abstracts

Speaker: Deborah Loewenberg Ball
Title: Doing Mathematics in and on Teaching
Abstract: Thirty years ago, my collaboration with the mathematician Hyman Bass began with a simple invitation to view a video recording of a mathematics lesson from my third-grade classroom. The task I proposed was for him to identify the mathematics he saw going on. What emerged was that, for him, studying the mathematics at play in elementary teaching and learning was itself a particular form of mathematical practice. In ways that were consonant with his work in disciplinary mathematics it involved bringing to bear not only foundational mathematical ideas but also fundamental aesthetic and orientations that characterize rigorous mathematical thinking. This talk will make visible what has been involved in doing mathematics in and on teaching by engaging attendees in close examination of specific examples. Key qualities of the practice include a proclivity for close reading and careful attention to details of language and representation, an orientation to see and look for connections, an interest in what makes things "the same," a focus on the demands of naming concepts and judging when an idea warrants a name, attraction to notions of mathematical elegance, an orientation to compression, and a relentless push to abstraction. The practice of mathematics in and on teaching inherently brings to the fore conflict and disagreement and yet shines a light into the unrecognized mathematical depth and sophistication of elementary school mathematics. This work, an important part of his mathematical legacy represents a unique methodological and theoretical contribution to the analysis of teaching and learning.

Speaker: Sybilla Beckmann
Title: Meanings for number in school mathematics and antiquity and implications for multiplicative reasoning
Abstract: In school mathematics the concept of number expands from counting numbers to integers, rational numbers, and real numbers. But what do these numbers mean for students, and what should they mean? I argue that in school mathematics, the concept of number should be a coordination of meanings from three ontologically distinct categories: position (ordinal), quantity (cardinal), and relative-size. From this perspective, very young children must learn to coordinate position and quantity meanings of counting numbersâĂŤa perspective that has been used to develop effective teaching-learning paths. I argue that older students must learn to coordinate quantity and relative-size meanings of number, and that this coordination is essential for understanding measurement, fractions, multiplication, division, and algebraic expressions. Yet the need for such a coordination does not seem to have been

explicitly recognized or emphasized in mathematics education.

In the history of mathematics, the concept of number also expanded from counting numbers to integers, rational numbers, and real numbers. Perhaps less well known is that the meaning of what we now call natural numbers has also changed since the work of Euclid and Diophantus in antiquity. The notion of relative-size was not included in the concept of number, although proofs and solution methods coordinated these two concepts. Diophantus worked with kinds of monomial and polynomial expressions that relied on a premodern interpretation of number. He therefore interpreted his expressions differently than we interpret our expressions today. In this presentation I show that an everyday meaning for number, and some ways of interpreting monomial expressions, are consistent with meanings and interpretations from antiquity. When combined with a failure to coordinate quantity and relative-size meanings, this could explain some of the difficulties with measurement, fractions, multiplication, division, and algebraic expressions.

Speaker: Imani Goffney
Title: The work of Dr. Hyman Bass: Leveraging Mathematical Expertise for Social Good
Abstract: Despite having achieved wide-spread recognition as a leading mathematician, Dr. Hyman Bass has continued actively engaging in professional work driven by his deep curiosity. In this talk, I will share reflections on our professional experiences and over 20 year relationship providing examples of his efforts with being a life long learner. Current and future generations will need mathematicians like Dr. Bass who collaborate to improve the quality of the research and to support researchers with producing high quality work, especially on topics critical for equity, justice, and democracy.. I will focus on the impact of his approaches out of respect for significant contributions he has made to the field in the last 67 years, to illustrate the way his collaborations improved the quality of the research and positively impacted the researchers involved in the work, which serves as a model for the work of current and future mathematicians.

Speaker: Gerald A. Goldin
Title: Fostering Mathematical Engagement
Abstract: The prevalence of dislike and anxiety toward mathematics in our broader society suggests that we need a fundamentally new approach to its teaching. After distinguishing three domain of human mental activity = cognition, affect, and conation. I will mention briefly several constructs important to our study of mathematical affect and engagement. These include emotions as representations, affective pathways, beliefs, mathematical intimacy, motivating desires, and engagement structures. Finally, I advocate for a radical shift in education toward giving serious attention to fulfilling the fundamental, universal needs of human beings for students "in the moment" in our mathematics teaching.

Speaker: Nick Wasserman
Title: Joint work: Reflections on Building Bridges between Mathematics Educators and Mathematicians
Abstract: In recognition of their important contributions to both mathematics and education, this talk will reflect on some ideas about building bridges between mathematics educators and mathematicians. It will revolve roughly around three aspects. First, the idea of teaching as a site of applied mathematics, and aspects of the ULTRA project in secondary mathematics teacher preparation. Second, the importance of mathematical practice in education, and the use of "pedagogical mathematical practices" to facilitate connection-making in teacher education. Third, the ways in which mathematical thinking can inform teaching and educational research, and vice versa, and how this has been productive in some of my own

work with mathematical representations.

Speaker: Suzanne Wilson
Title: Mathematicians as Public Intellectuals: A Rumination
Abstract: Academics are familiar with service and, in some fields, outreach; roles we are expected to take on as part of the privilege of working in higher education and that involve engagement with those in our discipline, with other academics, and often with broader groups of stakeholders. Public intellectuals are scholars who choose to engage in civic problems; that is, problems affect a community, society, or the nation, involve the common good, and require collective action or government intervention. Civic issues involve complex debates about different perspectives. Using the illustrative case of Hyman Bass, I argue that mathematicians are essential as public intellectuals to the civic work of public education and that their role is both variegated and fraught. My goal is not to argue the inherent goodness of one particular form of public intellectual work but rather, to offer some insights into the range of ways that intellectuals, and in this case, mathematicians, have and might, be civically engaged in public education.

Refreshments

Breakfast and afternoon tea will be provided

Lunch options (Busch Campus)

Rutgers University Busch Student Center (Take-away, pizza, sandwiches, Chinese)

Rutgers University Busch Faculty Dining Hall (Full entrees, salad bar, sandwiches)

Internet access

Eduroam or cell phone hotspot (Rutgers has no guest email)

Blackboards and projector

Blackboards and a projector are available in both classrooms.

Slides for the projector must be sent the morning of your talk.

Parking

Your car must be registered in advance.