November 11, 2021 (Thursday), 4:10 pm

Colloquium- Simple groups of dynamical origin SC5211

Volodymyr Nekrashevych, Texas A&M
Meeting ID: 998 6775 5871
Pass code: 527745
https://vanderbilt.zoom.us/j/99867755871?pwd=ZVdxT3o4VngzbkREZ2JWekhuTjQ5Zz09
Historically, the first examples of simple groups (found by Galois) were alternating groups. We will discuss their infinite generalizations associated with discrete dynamical systems on Cantor sets. Properties of these groups are intimately related to classical properties of dynamical systems. Such conditions as simplicity and finite generation of the groups are equivalent to standard conditions for dynamical systems: minimality and expansivity. This class of groups is also a source of examples of simple groups with prescribed properties: amenability, torsion, intermediate growth, and others, all of which are proved by analyzing the underlying dynamical system.

Host: Alexander Olshanskiy

January 13, 2022 (Thursday), 3:10 pm

Black holes: The inside story of gravitational collapse

Maxime Van De Moortel, Princeton University
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What does the interior of a black hole look like? Beyond the astrophysical motivation, it turns out that answering this question is at the heart of profound conjectures in General Relativity. One of them is the celebrated Penrose's Strong Cosmic Censorship Conjecture supporting the deterministic character of the theory of gravitation. I will present recent advances on this topic, based on modern techniques in hyperbolic PDEs and Differential Geometry, and describe outstanding problems.

January 20, 2022 (Thursday), 4:10 pm

Gapped Ground State Phases of Quantum Lattice Models

Amanda Young, TU Munich
Meeting ID: 920 3292 5113
Passcode: 977579

Quantum spin systems are many-body physical models where particles are bound to the sites of a lattice. These are widely used throughout condensed matter physics and quantum information theory, and are of particular interest in the classification of quantum phases of matter. By pinning down the properties of new exotic phases of matter, researchers have opened the door to developing new quantum technologies. One of the fundamental quantities for this classification is whether or not the Hamiltonian has a spectral gap above its ground state energy in the thermodynamic limit. Mathematically, the Hamiltonian is a self-adjoint operator and the set of possible energies is given by its spectrum, which is bounded from below. While the importance of the spectral gap is well known, very few methods exist for establishing if a model is gapped, and the majority of known results are for one-dimensional systems. Moreover, the existence of a non-vanishing gap is generically undecidable which makes it necessary to develop new techniques for estimating spectral gaps. In this talk, I will discuss my work proving non-vanishing spectral gaps for key quantum spin models, and developing new techniques for producing lower bound estimates on the gap. Two important models with longstanding spectral gap questions that I recently contributed progress to are the AKLT model on the hexagonal lattice, and Haldane's pseudo-potentials for the fractional quantum Hall effect. Once a gap has been proved, a natural next question is whether it is typical of a gapped phase. This can be positively answered by showing that the gap is robust in the presence of perturbations. Ensuring the gap remains open in the presence of perturbations is also of interest, e.g., for the development of robust quantum memory.
A second topic I will discuss is my research studying spectral gap stability.

January 27, 2022 (Thursday), 4:10 pm

The characteristic gluing problem of general relativity

Stefan Czimek, Brown University
Zoom Meeting ID: 975 6980 5672 Passcode: 553214
The Einstein equations describe the dynamics of space-time in general relativity. It is well-known that — analogous to the case of Maxwell's equations — initial data for the Einstein equations needs to satisfy constraint equations. One approach to study the rigidity and flexibility of the Einstein equations is by considering gluing problems for initial data. The so-called spacelike gluing problem for initial data on slices of constant time has been intensively studied by Riemannian geometers. In this talk I will present recent work with S. Aretakis and I. Rodnianski, where we introduce the so-called characteristic gluing problem for initial data along light cones (i.e. characteristic hypersurfaces for the Einstein equations). The characteristic gluing problem is fundamentally different from the spacelike problem, and displays novel rigidity and flexibility features. We moreover show how to apply our characteristic gluing to prove gluing constructions for spacelike initial data. Towards the end of the talk, I will discuss future directions.

February 1, 2022 (Tuesday), 4:10 pm

Special Colloquium

Location- Stevenson 1206
Location- Stevenson 1206

February 3, 2022 (Thursday), 4:10 pm

Special Colloquium

Location- SC 5211
Location- SC 5211

February 10, 2022 (Thursday), 4:10 pm

Special Colloquium

Location- SC 5211
Location- SC 5211

February 15, 2022 (Tuesday), 4:10 pm

Special Colloquium

Location: SC 1206
Location: SC 1206

February 22, 2022 (Tuesday), 4:10 pm

Special Colloquium

Location- SC 1206
Location- SC 1206

April 15, 2022 (Friday), 12:10 pm

Colloquium- Insights from Two National Studies of Precalculus through Calculus 2-Buttrick 103

Chris Rasmussen, San Diego State University

In this presentation I report on results and insights from two national studies of Precalculus through Calculus 2. The first project, *Progress through Calculus*, is an investigation of the factors that influence student success over the Precalculus through Calculus 2 (P2C2) sequence required of most STEM majors. As part of this project we conducted a census survey of all mathematics departments that offer a graduate degree in mathematics. From this, I report the viewpoints of departments about features shown to support students' success, as well as the extent to which these features are being implemented across the country. The second project, *Student Engagement in Mathematics through an Institutional Network for Active Learning,* is investigating departmental change that contributes to teaching and learning environments that improve student learning in the P2C2 sequence, with a particular focus on the use of active learning strategies. Changing department culture, norms, and practices to support widespread use of active learning is notoriously difficult, and case studies of departments that have successfully made such changes are rare. I highlight the practices and policies of a research-oriented mathematics departments that has made considerable progress on the challenge of infusing active learning into their introductory mathematics courses in sustainable and widespread ways. In particular, I highlight how departmental and institutional leadership; P2C2 structures such as course coordination; use of data; student resources such as learning or tutoring centers; and professional development have been mutually supportive to initiate, implement, and sustain active learning in P2C2 courses at these two institutions.

April 19, 2022 (Tuesday), 4:10 pm

Colloquium- Representations of Quantum Group Categories- SC 1206

Cain Edie-Michell- UCSD

Given any algebraic object, it is important to study the representations of that object. This is particularly true for the tensor categories constructed from quantum groups. In this setting the representations classify certain conformal field theories, and give rise to highly non-trivial subfactors of many Von Neumann algebras. In this talk I will present some progress in the classification of these representations. Our results show the existence of several infinite families, along with a handful of sporadic examples.

April 21, 2022 (Thursday), 4:10 pm

Colloquium- Congruence permutability is prime- SC- 5211

Miklos Maroti, University of Szeged,
A variety or equational class is a class of all algebras (algebraic structures of a given signature) satisfying a given set of identities. We say that a variety K interprets in a variety V if K has a set of identities such that if we replace the operation symbols of K with terms of V, then the obtained set of identities hold in V. As an example, the variety of groups interprets in the variety of rings (using its additive structure). As easily seen, interpretability is a quasiorder on the class of varieties. The blocks of this quasiorder are called the interpretability types. Garcıa and Taylor introduced the lattice of interpretability types of varieties that is obtained by taking the quotient of the class of varieties quasiordered by interpretability and the corresponding equivalence relation. We call a variety V congruence permutable if the variety K defined by m(x,y,y)=x and m(y,y,x)=x interprets in V. For example, the varieties of groups, rings and vector spaces are congruence permutable. In 1984 Garcia and Taylor formulated the conjecture that congruence permutability is a prime element in the lattice of interpretability types. We will give combinatorial proof of this conjecture and settle it in its full generality. This is joint work with G. Gyenize and L. Zadori.

May 5, 2022 (Thursday), 4:10 pm

Colloquium- Homotopical methods in Floer theory

Mohammed Abouzaid, Columbia

The free loop space of a symplectic manifold is equipped with a canonical (multivalued) functional, which assigns to a 1-parameter family of loops the area of the cylinder that they sweep. Floer's insight that one can assign a homology group to this context by an appropriate reformulation of Morse theory led to a revolution in symplectic topology. Applied to toy examples, Floer's homology groups agree with ordinary homology. I will discuss an extension of Floer's idea to generalised cohomology theories. This was first envisioned by Floer himself, but the area of symplectic topology has finally reached the stage where we have concrete applications, which I will describe.