ABSTRACTS OF TALKS AND POSTERS

Listed alphabetically by presenters's last name

Bernd Ammann, University of Hamburg, Germany
Poster Abstract: We are studying a nonlinear eigenvalue problem for the Dirac operator on a closed Riemannian spin manifold. The non-linearity is of Yamabe type. The solutions of this equation has two applications. If the dimension of the manifold is 2, then one obtains periodic conformal immersions of constant mean curvature into R^3. The other application (which works in any dimension) gives a uniform lower bound to the first positive eigenvalue of the Dirac operator, and gives an answer to the question whether this bound is attained.

In the poster you will also see some other research areas of mine: analysis on complete manifolds, small eigenvalues of the Dirac operator and eigenvalue estimates for the Dirac operator on surfaces.

David Borthwick, Emory University
Title: Determinants on Infinite-Volume Surfaces.
Abstract: We will discuss joint work with P. Perry and C. Judge on defining the determinant of the Laplacian on a surface with hyperbolic funnel ends. The standard zeta regularization available in finite volume does not apply in these cases, but meaningful and useful definitions of the determinant are still possible. Applications to isospectral problems will be discussed.

Sun-Yung Alice Chang, Princeton University
Title: A conformally invariant sphere theorem in four dimensions.
Abstract: In the talk, I will discuss a L^2 curvature condition which characterizes the four sphere; the condition is optimal and "conformally invariant". I will also mention some possibility to extend this analysis to characterize other conformal classes such as the complex projective plane. This is a joint with Matt Gursky and Paul Yang.

Harold Donnelly, Purdue University
Title: Quantum Unique Ergodicity.
Abstract: Consider a compact Riemannian manifold with ergodic geodesic flow. Quantum ergodicity is generalized from orthonormal bases of eigenfunctions of the Laplacian to packets of eigenfunctions. It is shown that this more general result is sharp. Namely,there may exist exceptional packets of eigenfunctions which concentrate on a submanifold.

Stewart Dowker, University of Manchester
Title: Statistical mechanics on spheres, elliptic functions and number theory.
Abstract: The internal energies of conformally invariant free scalars and spinors on odd d-dimensional spheres are given in terms of Eisenstein series and are written as polynomials in terms of just two quantities. At temperatures associated with singular moduli and complex multiplication of elliptic functions they are expressed finitely in terms of Gamma functions and algebraic numbers. The specific heat is discussed using a modular covariant derivative. Some historical remarks are made concerning the Kronecker Grenzformel and the Selberg-Chowla results.

Fan Chung Graham, University of California, San Diego
Title: Can you hear the shape of a network?

Svetlana Jitomirskaya, University of California, Irvine
Title: Delocalization in random polymer models

Yulia Karpeshina, University of Alabama at Birmingham
Title: On the Schrödinger operator with a periodic electromagnetic potential in two dimensions.
Abstract: We discuss spectral properties of the above operator in the high energy region. Partially they are similar to those of the operator with just an electric potential. However, there are essential differences too, since a magnetic potential is a much stronger perturbation of the Laplacian then an electric potential. To understand these properties we use a "model functions" approach. We construct asymptotic formulae for Bloch eigenvalues, Bloch eigenfunctions, isoenergetic surfaces and the integrated density of states.

Richard Kenyon, Université de Paris-Sud
Title: Determinants and phase transitions in the planar dimer model
Abstract: This is joint work with Scott Sheffield and Andrei Okounkov. We study a particular statistical mechanics model, the dimer model (= domino tilings = perfect matchings) on $\mathbb{Z}^2$. In 1961 Kasteleyn, Temperley, and Fisher showed how to compute the partition function of the model using the determinant of a discrete Dirac operator on $\mathbb{Z}^2$. Generalizing to arbitrary bipartite periodic planar graphs, we find (on each graph) a natural two-parameter family of invariant Gibbs measures with a quite nontrivial phase space. Essentially all the physical features of these measures are reflected in properties of the spectrum of the corresponding discrete Dirac-type operator, which has a very simple and computable form.

Deborah Koslover and Melinda Schulteis, University of California, Irvine
Poster Title: Bloch Electron in a Perpendicular Magnetic Field.
Abstract: The problem of an electron moving in a two dimensional crystalline lattice subjected to a perpendicular uniform magnetic field has been studied by both mathematicians and physicists, using an approximation where the electron is constrained to hop only to nearest neighbors. We are studying two models where the electron is allowed to hop to second nearest neighbors as well. For each model, we have shown a region of localization, i.e. pure point spectrum with exponentially decaying eigenfunctions. We are currently working to strengthen our result to strong dynamical localization and to further characterize the spectra of these models.

Richard Laugesen, University of Illinois
Poster Title: Does a circular plate buckle most easily?
Abstract: In 1951, Pólya and Szegő conjectured that among all clamped plates of the same area that are subject to uniform lateral compression, the circular plate has the minimal buckling load. (Here the buckling load is the lowest eigenvalue of $\Delta\Delta u = -\lambda\Delta u$ with $u \in W_0^{2,2}$.) Willms and Weinberger gave a boundary-variational proof assuming the minimizing domain is smooth. I am attempting to circumvent this regularity requirement by using Julia and Schiffer variations from complex analysis. Work in progress!

Richard Melrose, Massachusetts Institute of Technology
Title: The Laplacian plus a potential with radial limit at infinity.
Abstract: In joint work with Andrew Hassell and Andras Vasy we have examined

the spectrum of the operator $\Delta + V$ where Δ is the Laplacian on Euclidean space (or much more generally the Laplacian on a compact manifold with boundary which has a scattering metric on its interior – a type of asymptotically flat metric) and V is a classical symbol of order 0 (resp. a smooth function). The spectrum is geometrically associated to the critical points of the restriction of the potential to the sphere at infinity (resp. boundary). The corresponding eigenfunctions can be described reasonably explicitly in case the potential is Morse at infinity, as can the scattering matrix.

Peter Perry, University of Kentucky: Memorial lecture for Bob Brooks
Title: Spectral geomtry of eigenvalues and resonances: A retrospective on the work of Robert Brooks.
Abstract: Spectral geometry has its roots in the study of the geometric content of eigenvalues on a compact surface or the Dirichlet eigenvalues of a bounded planar domain. On the one hand, explicit constructions of discrete and continuous families of manifolds with the same spectrum show that the spectrum does not completely determine the geometry of a manifold; on the other, compactness theorems show that the spectrum does place strong constraints on the geometries allowed by a given spectrum. Here we will explore the techniques used in each of these two approaches and discuss their recent application to the spectral geometry of resonances.

Jie Qing, University of California, Santa Cruz
Title: On conformally compact Einstein manifolds.
Abstract: We will talk about our recent research on conformally compact Einstein manifolds with its conformal infinity of positive Yamabe constant. We will introduce to you conformal compactifications by eigenfunctions. And as applications we will show the uniqueness of conformally compact Einstein manifolds with the round sphere as its conformal infinity and we will study the topology of conformally compact Einstein manifolds with relatively large renormalized volume.

Abdul Rahman, Howard University
Poster Title: On the geometry and homology of certain simple stratified varieties.
Abstract: I have been engaged in developing a homology theory for stratified varieties motivated from gauged linear sigma models from String theory. These stratified spaces are formed by taking the disjoint union of a singular Calabi-Yau three-fold (conifold), the singular point, and an antenna (S2). The homology of these spaces, excepting the middle dimension, satisfies the Kahler package, the mirror map, and String theory. Future work will consist of studying more complex singularities in addition to examining candidate sub-varieties that can remove middle dimension obstructions.

Peter Sarnak, Princeton University and New York University
Title: L^4 norms of eigenfunctions on the modular surface.

Melinda Schulteis and Deborah Koslover, University of California, Irvine
Poster: See title and abstract listed under Koslover.

Florin Spinu, Princeton University
Poster Title: Uniform boundedness of the L^4 norm of the Eisenstein series on $PSL(2, Z)$.

Jean Steiner, University of California, San Diego
Poster Title: Analogs to the Mass, and the Positive Mass Theorem on Spheres

Abstract: We consider two mass-like quantities on even dimensional manifolds. The Robin mass is the constant term in the asymptotic expansion of the Green's function for the Paneitz operator(on surfaces the Paneitz operator is the Laplacian). We relate this quantity to a spectral invariant and describe the behavior of the Robin mass under a conformal change of metric. Additionally, we give a heuristic argument motivated by the Yamabe Theorem yielding a mass-like quantity on spheres. On spheres, we show that this quantity depends only on the conformal representative, and it is minimized at the standard round metric. We also investigate a few specific examples.

Audrey Terras, University of California, San Diego
Title: Selberg's Trace Formula - Discrete and Indiscrete
Abstract: We will compare 3 different versions of the trace formula: the original trace formula for compact Riemann surfaces, an analogue for finite graphs, and finally an analogue for the finite group $GL(2, F)$, where F is a finite field. Applications to spectral theory and zeta functions will be considered.

Gang Tian, Massachusetts Institute of Technology
Title: Kahler-Ricci solitons on compact manifolds.

Xiangjin Xu, Johns Hopkins University
Poster Title: Gradient estimates for eigenfunctions of Riemannian manifolds with boundary and Hormander multiplier theorem
Abstract: On compact Riemannian manifolds (M, g) with C^2 boundary, the L^∞ gradient estimates for the eigenfunctions of the Dirichlet Laplacian is proved. L^∞ estimates and gradient estimates for the eigenfunctions for Neumann Laplacian are proved too. Using the gradient estimates for Dirichlet Laplacian, we show the Hörmander multiplier theorem for Laplacian operator on compact manifolds with boundary.

Steven Zelditch, Johns Hopkins University
Poster: TBA