List of Speakers - Titles and abstracts.

Michael AIZENMANN
Resonant Delocalization on the Complete Graph.
Abstract: The random Schödinger operator provides an example of an operator with many local quasi-modes which under certain conditions exhibits bands of semi-delocalized stated (in addition to the localized eigenfunction which are known to occur through most of the operator's spectrum). In analyzing this phenomenon it is of help to employ some generally useful properties of the scaling limits of random functions in the Pick class. We find that in energy windows where semidelocalized eigenfunction occur the rescaled spectrum resembles that of the Seba process, which would be defined in the talk. The eigenfunctions in such regimes are delocalized in the L^1 sense, though not in L^2. The results are found to be in agreement with a heuristic condition for the emergence of resonant delocalization in terms of the tunneling amplitude among quasi-modes.

Based on the joint works:

M.A., M. Shamis, and S. Warzel: "Resonances and Partial Delocalization on the Complete Graph", arXiv:1405.3951.

M.A. and S. Warzel: "On the ubiquity of the Cauchy distribution in spectral problems", arXiv:1312.7769.

Volker BACH
Diagonalizing Quadratic Boson Operators by Unitary Flows.
Abstract: A nonautonomous, non-linear evolution equation on the space of operators on a complex Hilbert space is studied. This evolution equation derives from the BrocketWegner flow that was proposed to diagonalize matrices and operators by a strongly continuous unitary flow. The solution of the flow equation leads to a diagonalization of Hamiltonian operators in boson quantum field theory which are quadratic in the field. This is joint work with Jean-Bernard Bru

Sven BACHMANN
The spectral gap of smooth families of quantum spin systems.
Abstract: A quantum phase transition is commonly referred to as a point in a family of gapped Hamiltonians where the spectral gap closes. In the absence of a general perturbation theory for quantum spin systems in the thermodynamic limit, I will discuss necessary, and sufficient, conditions for a transition, and present explicit constructions of paths of uniformly gapped Hamiltonians in one dimension.

Laurent BRUNEAU
Landauer-Buttiker currents, Thouless conductance and spectrum.
Abstract: Thouless conductance (or parameter) has played an important role in the scaling theory of localization. After a brief heuristic explanation of the notion of Thouless conductance of a finite sample, we shall explain how to extract a well defined mathematic quantity for it out of its heuristic definition. We then relate it to the currents between electronic reservoirs through the sample as given by the Landauer-Buttiker formula, making precise the notion of so-called "optimal feeding". We will

also show how the behaviour of the Thouless conductance, and of Landauer-Buttiker currents, as the size of the sample grows is linked to the spectrum of the corresponding infinite sample. This is a joint work with V. Jaksic, Y. Last and C.-A. Pillet

Wojciech DE ROECK
Many-Body Localization without quenched disorder.
Abstract: I will discuss our work (joint with Francois Huveneers) on many-body localization (or absence thereof) in translation invariant systems. The most spectacular part of it is unfortunately non-rigorous, but it has also lead to well-defined and interesting toy models that can be tackled mathematically.

Jérémy FAUPIN
On quantum electrodynamics of atomic resonances.
Abstract: We consider a simple model of an atom interacting with the quantized electromagnetic field. The atom has a finite mass, finitely many excited states, and an electric dipole moment proportional to the elementary electric charge. We establish the existence of resonances associated to the excited states of the atom, and we prove that these resonances are analytic functions of the total momentum p and of the coupling constant, provided that $|p| < mc$ (where m is the mass of the atom and c is the speed of light) and that the coupling constant is small enough.

The proof relies on a somewhat novel inductive construction involving a sequence of "smooth Feshbach-Schur maps" applied to a complex dilatation of the original Hamiltonian, which yields an algorithm for the calculation of resonance energies that converges super-exponentially fast.

Joint work with M. Ballesteros, J. Froehlich and B. Schubnel

Gian Michele GRAF
Bulk-edge duality for topological insulators.
Abstract: Topological insulators are materials, which are conducting at their edges, though not in the bulk. Their Hamiltonians can not be deformed into those of ordinary insulators while retaining (fermionic) time-reversal invariance and the insulating property. After reviewing some of the reasons for the interest they recently raised, indices will be defined for insulators, telling apart the two types. We will do so first for two-dimensional insulators: Once based on the electronic bulk states, and once on the edge states. We will state the equivalence in full, but explain it in a simpler setting, where it is related to Levinson's theorem of scattering theory. If time permits, we'll comment on recent work on graphene, where a phase diagram has been obtained using bulk-edge duality. (Based on work with M. Porta; A. Agazzi, J.-P. Eckmann)

Dietrich HÄFNER
Asymptotic completeness for superradiant Klein-Gordon equations and applications to the De Sitter Kerr metric.
Abstract: Superradiance appears on spacetimes which have no global timelike Killing vector field. In this situation there is no positive conserved energy for the wave equation and natural positive energies can grow in time even for the linear wave equation. The most famous example is that of the (De Sitter) Kerr metric which describes rotating black holes. We present in this talk an abstract framework for this phenomenon

and show an asymptotic completeness result for the Klein-Gordon equation within this framework. Applications to the De Sitter Kerr metric are given.

This is joint work with Vladimir Georgescu and Christian Gérard.

Eman HAMZA
Some Spectral properties of Non-Unitary Band operators.
Abstract: We consider families of random non-unitary contraction operators that appear naturally in the analysis of certain random quantum walks. We will discuss several deterministic and almost sure results about the location and nature of the spectrum of such non-normal operators as a function of their parameters. We will then relate these results to the dynamics the random quantum walks.

David HASLER
Ground state properties in non-relativistic QED
Abstract: We condsider ground state properties in non-relativstic qed. We talk about results, which show that the ground state is an analytic function of external parameters or the coupling constant. We extend these results to situations where the ground state is degenerate.

Svetlana JITOMIRSKAYA
Small coupling Anderson localization for a discontinuous quasi periodic potential
Abstract: One-dimensional quasi periodic operators are well studied for analytic potentials where a metal-insulator (in particular, ac to pp spectrum) transition occurs for a.e. frequency as the coupling increases from zero to infinity.

In this work we show that under the bi-Lipshitz condition on the potential, for a.e. phase and frequency there is Anderson localization for any coupling. This is the first example of pp spectrum at small coupling for bounded quasi periodic-type operators, or more generally for ergodic operators with underlying systems of low disorder. Moreover, for such potentials at (moderately) high couplings localization is uniform, thus providing the first natural example of an operator with uniform spectral and dynamical localization. The talk is based on the work joint with I. Kachkovskiy.

Abel KLEIN
Unique continuation principle for spectral projections of Schrödinger operators and optimal Wegner estimates for random Schrödinger operators.
Abstract: We prove a unique continuation principle for spectral projections of Schrödinger operators. Given a Schrödinger operator $H = -\Delta + V$ on $\mathrm{L}^2(\mathbb{R}^d)$, let H_Λ denote its restriction to a finite box Λ with either Dirichlet or periodic boundary condition. We prove unique continuation estimates of the type

$$\chi_I(H_\Lambda) W \chi_I(H_\Lambda) \geq \kappa\, \chi_I(H_\Lambda) \quad \text{with} \quad \kappa > 0,$$

for appropriate potentials $W \geq 0$ and intervals I. As an application, we obtain optimal Wegner estimates at all energies for for one-particle and multi-particle continuous random Schrödinger operators with alloy-type random potentials.

References

[1] Abel Klein: Unique continuation principle for spectral projections of Schrödinger operators and optimal Wegner estimates for non-ergodic random Schrödinger operators. Comm. Math Phys. **323**, 1229-1246 (2013).

[2] Abel Klein and Son T. Nguyen: Bootstrap multiscale analysis and localization for multi-particle continuous Anderson Hamiltonians. J. Spectr. Theory (to appear). arXiv:1301.5268

Frédéric KLOPP

Interacting one dimensional electrons in a Poisson random potential.

Abstract: In this talk, we consider the one dimensional Schödinger operator with a repulsive Poisson random potential. We consider n interacting electrons located in this random background and restricted to an interval of length L. We study the limit of the ground state and of the ground state energy (per particle) of this quantum system when n and L go to infinity in such a way that n/L converges to a fixed positive density, say, ρ. The density of particles ρ is our main parameter to control the thermodynamic limit; it will be assumed to be small.

Elliott LIEB

Entropy and Entanglement Bounds for Reduced Density Matrices of Fermionic states.

Abstract: One of the important aspects of many-body quantum mechanics of electrons is the analysis of two-body density matrices. While the characterization of one-body density matrices is well known and simple to state, that of two-body matrices is far from simple – indeed, it is not fully known. In this talk I will present joint work with Eric Carlen in which we study the possible entropy of such matrices. We find, inter alia, that minimum entropy is achieved for Slater determinant N-body parent functions. Thus, from the entropic point of view, Slater determinants play the same role as condensates play for bosons.

Peter MÜLLER

Anderson's Orthogonality Catastrophe.

Abstract: We give an upper bound on the modulus of the ground-state overlap of two non-interacting fermionic quantum systems with N particles in a large but finite volume L^d of d-dimensional Euclidean space. The underlying one-particle Hamiltonians of the two systems are standard Schrdinger operators that differ by a non-negative compactly supported scalar potential. In the thermodynamic limit, the bound exhibits an asymptotic power-law decay in the system size L, showing that the ground-state overlap vanishes for macroscopic systems. The decay exponent can be interpreted in terms of the total scattering cross section averaged over all incident directions. The result confirms and generalises P. W. Anderson's informal computation [Phys. Rev. Lett. 18, 1049–1051 (1967)].

Annalisa PANATI

Full counting statistics of return to equilibrium.

Abstract: We study microscopic Hamiltonian model describing a finite level quantum system $\mathcal{S}$ coupled to an infinitely extended thermal reservoir $\mathcal{R}$. Initially, the system

$\mathcal{S}$ is in an arbitrary state while the reservoir is in thermal equilibrium at inverse temperature β. Assuming that the coupled system $\mathcal{S} + \mathcal{R}$ is mixing with respect to the joint thermal state, we study the Full Counting Statistics (FCS) of the energy transfers $\mathcal{S} \to \mathcal{R}$ and $\mathcal{R} \to \mathcal{S}$ in the process of return to equilibrium. We consider the FCS associated measures and we study their large time limit $t \to \infty$, followed by the weak coupling limit $\lambda \to 0$ and prove that the limiting measures coincide. This result strengthens the first law of thermodynamics for open quantum systems. The proofs are based on modular theory of operator algebras and quantum transfer operator representation of FCS.

Claude-Alain PILLET
The Landauer Principle in quantum statistical mechanics.
Abstract: ABSTRACT: In a celebrated 1961 paper, Landauer formulated a fundamental lower bound on the energy dissipated by computation processes. Since then, there has been many attempts to formalize, generalize and contradict Landauer's analysis. The situation became even worse with the advent of quantum computing. In a recent enlightening article, Reeb and Wolf sets the game into the framework of quantum statistical mechanics, and finally gave a precise mathematical formulation of Landauer's bound. I will discuss parts of this analysis and present some extensions of it that were obtained in a joint work with V. Jaksic.

Georgi RAIKOV
Spectral and scattering properties of twisted waveguides.
Abstract: I will consider the Dirichlet Laplacian H_θ in a 3D twisted waveguide with rotation angle θ depending on the longitudinal variable. First, I will show that the wave operators for the operator pair $(H_{\theta_1}, H_{\theta_2})$ exist and are complete, provided that the difference of the derivatives $\theta_1' - \theta_2'$ decays fast enough at infinity. Further, I will consider the case where $\theta' = \beta - \epsilon$ with a constant β, and a decaying function ϵ; if ϵ vanishes identically, then the operator H_θ is analytically fibered, and its spectrum is purely absolutely continuous. Using suitable Mourre estimates, I will show that the singular continuous spectrum of H_θ is empty if ϵ decays fast enough at infinity. Under appropriate assumptions on β and ϵ, I will discuss the asymptotic distribution of the discrete spectrum of H_θ near the bottom of its essential spectrum. Finally, I will present recent results concerning the asymptotic distribution of the discrete spectrum of H_θ if $\theta' = \beta - \epsilon$ where β is a periodic function and ϵ decays at infinity.

Nicolas RAYMOND
Magnetic WKB constructions.
Abstract: This talk will be devoted to the semiclassical magnetic Laplacian. Until now WKB expansions for the eigenfunctions were only established in presence of a non-zero electric potential. In this talk we will tackle the pure magnetic case. Thanks to Feynman-Hellmann type formulas and a coherent states decomposition, we will present a magnetic Born-Oppenheimer theory. Exploiting the multiple scales of the problem, we will explain how we can solve an effective eikonal equation in pure magnetic cases and obtain WKB expansions. We will also investigate explicit examples for which we can improve our general theorem: global WKB expansions, quasi-optimal estimates of Agmon and upper bound of the tunelling effect (in symmetric cases). We will also apply our strategy to get more accurate descriptions of the eigenfunctions in

a wide range of situations analyzed in the last two decades.

This is joint work with V. Bonnaillie-Noël and F. Hérau.

Hermann SCHULZ-BALDES
Invariants of disordered topological insulators.
Abstract: According to a widely accepted terminology, a topological insulator is a (independent) Fermion system which has surface modes that are not exposed to Anderson localization. This stability results from topological constraints given by non-trivial invariants like non-commutative Chern numbers and higher winding numbers, but sometimes also more subtle Z_2 invariants associated to adequate Fredholm operators with symmetries. Prime examples are quantum Hall systems, but the talk also considers chiral and BdG systems as well as time-reversal symmetric systems with Z_2 invariants.

Robert SEIRINGER
Validity of spin wave theory for the quantum Heisenberg model.
Abstract: We consider the quantum ferromagnetic Heisenberg model in three dimensions, for all spins $S = 1/2$. We rigorously prove the validity of the spin-wave approximation for the excitation spectrum, at the level of the first non-trivial contribution to the free energy at low temperatures. The proof combines a bosonic representation of the model introduced by Holstein & Primakoff with probabilistic estimates, localization bounds and functional inequalities.

(Joint work with Michele Correggi and Alessandro Giuliani)

Mira SHAMIS
Bounds on the Lyapunov exponent via crude estimates on the density of states.
Abstract: We shall discuss lower estimates for the Lyapunov exponent for one-dimensional Schrödinger operators, particularly, for the skew shift, and for the linearization of the Standard Map.

Based on joint work with Tom Spencer.

Alexander SOBOLEV
Functions of self-adjoint operators in ideals of compact operators: applications to the entanglement entropy.
Abstract: Let A be a self-adjoint operator, and let P be an orthogonal projection. We study properties of the difference $f(PAP) - Pf(A)P$ in arbitrary quasi-normed ideals $\mathfrak{S}$. The focus is on discontinuous functions f. A typical example is the function $f(t) = |t|^\gamma$ with $\gamma \in (0, 1)$.

We apply the obtained results to study the entanglement entropy of free fermions.

Jan-Philip SOLOVEJ
The classical entropy of quantum states
Abstract: To quantify the inherent uncertainty of quantum states Wehrl ('79) suggested a definition of their classical entropy based on the coherent state transform. He conjectured that this classical entropy is minimized by states that also minimize the Heisenberg uncertainty inequality, i.e., Gaussian coherent states. Lieb ('78) proved this conjecture and conjectured that the same holds when Euclidean Glauber coherent

states are replaced by $SU(2)$ Bloch coherent states. This conjecture was settled last year in joint work with Lieb. Recently we simplified the proof and generalized it to $SU(N)$ for general N. I will present this here. In proving the conjecture we study the quantum channels known as Universal Quantum Cloning Machines and determine their minimal output entropy.

Stefan TEUFEL
Peierls substitution for magnetic Bloch bands.
Abstract: We consider the one-particle Schrödinger operator in two dimensions with a periodic potential and a strong constant magnetic field perturbed by slowly varying non-periodic scalar and vector potentials, $\phi(\epsilon x)$ and $A(\epsilon x)$, for $\epsilon \ll 1$. For each isolated family of magnetic Bloch bands we derive an effective Hamiltonian that is unitarily equivalent to the restriction of the Schrödinger operator to a corresponding almost invariant subspace. At leading order, our effective Hamiltonian can be interpreted as the Peierls substitution Hamiltonian widely used in physics for non-magnetic Bloch bands. However, while for non-magnetic Bloch bands the corresponding result is well understood, both on a heuristic and on a rigorous level, for magnetic Bloch bands it is not clear how to even define a Peierls substitution Hamiltonian beyond a formal expression. The source of the difficulty is a topological obstruction: In contrast to the non-magnetic case, magnetic Bloch bundles are generically not trivializable. As a consequence, Peierls substitution Hamiltonians for magnetic Bloch bands turn out to be pseudodifferential operators acting on sections of non-trivial vector bundles over a two-torus, the reduced Brillouin zone.

As an application of our results we construct a family of canonical one-band Hamiltonians H_θ for magnetic Bloch bands with Chern number $\theta \in \mathbb{Z}$ that generalizes the Hofstadter model $H_{\theta=0}$ for a single non-magnetic Bloch band. It turns out that the spectrum of H_θ is independent of θ and thus agrees with the Hofstadter spectrum depicted in his famous (black and white) butterfly. However, the resulting Chern numbers of subbands, corresponding to Hall conductivities, depend on θ, and thus the models lead to different colored butterflies.

This is joint work with Silvia Freund.

Rafael TIEDRA DE ALDECOA
Resolvent expansions and continuity of the scattering matrix at embedded thresholds.
Abstract: We present an inversion formula which can be used to obtain resolvent expansions near embedded thresholds. As an application, we prove for a class of quantum waveguides the absence of accumulation of eigenvalues and the continuity of the scattering matrix at all thresholds. This is a joint work with Serge Richard.