Monday, 14th of September 2026

Index theory for solid state systems: from Jean's findings to more recent developments

Hermann Schulz-Baldes

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Topological View on Many-body Physics of Disordered Matter

Takeshi Egami

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Today's technologies are largely supported by crystalline solids, such as silicon in semiconductors. For this reason, most of theories in condensed-matter physics assume lattice periodicity. Therefore, they are powerless to non-crystalline matter, even though they, including water, are essential to our lives. We have been exploring the frontier of the science of dynamic aperiodic matter (DAM) through new experiments using modern scattering facilities, and through new theories backed by simulation. As a partner of enjoyable collaboration Jean Bellissard made key contributions to the theories of liquid and glass, through his topological theories and theories on the interaction of phonons with local structural fluctuations. Unlike gases, liquids are condensed matter in which atoms are strongly interacting with each other. To solve this dynamic many-body problem, the conventional perturbative field theories are inadequate, and totally novel approaches are required. In this talk I briefly summarize our experimental advances to characterize local dynamics of liquids, including superfluid ^{4}He and electrons as Fermi liquids, and how they led to a new proposal on the origin of high-temperature superconductivity. I then discuss Jean's theories on the mechanism of deformation in metallic glasses [1] and the origin of liquid viscosity [2]. They form the basis for the density wave theory of liquid we developed recently [3].

1. J. Bellissard, "Delone sets and material science: A program", in *Mathematics of Aperiodic Order*, edited by J. Kellendonk, D. Lenz, and J. Savinien, Progress in Mathematics Vol. 309 (Birkhäuser, Boston, 2015).
2. J. Bellissard and T. Egami, "Simple Theory of Viscosity in Liquids", *Phys. Rev. E*, **98,** 063005 (2018).
3. T. Egami and C. W. Ryu, "Structural Principles in Metallic Liquids and Glasses: Bottom-up or Top-down", *Frontiers in Materials*, **9,** 874191 (2022).

Ring states as a probe of topology

Sebastian Huber

ETH Zürich, Switzerland

Topological bands host stable mid-gap impurity states. These states carry a canonically gauge-fixed spinor whose Bloch texture provides an exact pointwise image, $\Phi: S2 \rightarrow S2$, of the host band's texture. I will discuss experiments on a silicon-based resonator network that characterize these mid-gap states and present results on the topological bounds governing their spatial footprint.

Diffraction as a unitary representation

Daniel Lenz

Friedrich-Schiller Universität Jena, Germany

We show how diffraction theory built around the autocorrelation measure can be understood as a unitary representation. This gives a new characterisation of pure point diffraction and unifies various earlier results. Moreover, it demonstrates structural similarities to the approach to diffraction via dynamical systems. (Joint work with Nicolae Strungaru)

Tuesday, 15th of September 2026

The Deift Conjecture and Generalized Almost Periodicity

David Damanik

Rice University, USA

This talk will present joint work with Long Li and Nicolae Strungaru on a new perspective on the Deift conjecture. This conjecture states that the Korteweg-de Vries (KdV) equation with almost periodic initial data admits global solutions that are almost periodic in space and time. There has been exciting progress on this conjecture in the past couple of decades. The status quo is that it has been confirmed for suitable classes of almost periodic initial data, and it has also been realized that almost periodic initial data may develop discontinuities, which are incompatible with Bochner/Bohr almost periodicity. Our work is motivated by recent work of Daniel Lenz, Timo Spindeler, and Nicolae Strungaru on the characterization of structures with pure point diffraction - the central property in mathematical quasicrystal theory. It had been understood for a long time that Bochner/Bohr almost periodicity is not the right notion in the diffraction context, but Lenz-Spindeler-Strungaru have only recently realized precisely which almost periodicity notions are the correct ones when studying and even characterizing key properties in diffraction theory. Armed with these realizations, we give the Deift conjecture a fresh look.

Mathematical engineering of topological metamaterials

Emil Prodan

Yeshiva University, New York, USA

In this talk, I will exemplify how Jean Bellissard's C*-algebraic program has helped us build a research in topological metamaterials. After briefly describing my current understanding of architected materials and their classification, I will present success stories where the C*-algebraic framework has been instrumental for fabrication of laboratory models displaying outstanding dynamical effects.

Consistent symmetry breaking and topological phases

Yuezhao Li

Max Planck Institute for Mathematics, Bonn, Gemany

Operators that are invariant under a symmetry group are also invariant under any of its finite-index subgroups. The K-theory equivariant indices for these subgroups must be consistent under the process of "symmetry breaking", that is, the natural inclusion maps between the C*-algebras generated by invariant operators. This yields a diagram of C*-algebras and their K-theory groups, whose directed colimit provides a dichotomy of weak/strong K-theory elements that occur in time-reversal symmetric topological insulators. This is based on joint work with Guo Chuan Thiang (Peking University).

Kitaev's Quantum Double Models and Their KMS States

Danilo Polo Ojito

Pontificia Universidad Javeriana, Colombia

Kitaev's quantum double models form a prototypical family of exactly solvable models exhibiting topological order and anyonic excitations. In this talk, I will explain how these models can be naturally formulated within the framework of C*-algebras, providing a robust algebraic description of their observables and excitations. Finally, I will determine the complete set of KMS states for the abelian quantum double models.

AI in Computational Condensed Matter Physics: From Materials Discovery to Machine-Learned Density Functionals

Thomas Kühne

Helmholtz-Zentrum Dresden-Rossendorf, Germany

Artificial intelligence is opening new routes to materials discovery and atomistic simulation. This talk explores its integration with density functional theory, covering high-throughput materials screening, symmetry-equivariant interatomic potentials, and Hamiltonian learning. Particular emphasis is placed on implementing the nonlocal Skala exchange-correlation functional in CP2K for molecular and periodic systems. We discuss complementary approaches based on atom-centered quadrature and native computational grids, highlighting the challenges of nonlocality, numerical convergence, and compatibility with GPW and GAPW methods. Preliminary results illustrate the potential of machine-learned density functionals while emphasizing the importance of physically consistent implementations and GPU acceleration for practical large-scale simulations.

Wednesday, 16th of September 2026

Spectral Defects in the Kohmoto model

Yannik Thomas

University of Potsdam, Germany

In this talk we study the spectral map associated to the Kohmoto model, which includes the Sturmian Hamiltonians and their periodic approximations. Due to a work by Bellissard, Iochum and Testard it is known that this map has discontinuities at each rational point. We aim to describe these spectral defects as a consequence of a localized perturbation of the underlying potential. If time permits we further show how one uses these information to compute spectral defects explicitly.
This talk is based on a joint work with Jean Bellissard and Siegfried Beckus.

Spectral flow distinguishes 1-d quasicrystalline topological insulators

Johannes Kellendonk

Université de Lyon, France

Aperiodic materials have a richer topological phase structure than periodic ones. These phases distinguish different classes of aperiodic materials. For 1-dimensional materials, this can be analysed by looking at a spectral flow of their edge eigenvalues. In this way we can distinguish, among quasicrystals, those which are entirely determined by their Bragg spectrum, like for instance the Fibonacci chain, from the others, like the period doubling chain, where there are phases which cannot be predicted by Bragg diffraction.