DVR 0065528

"Non-equilibrium dynamics"
within the programme "Quantum Paths"
April 23 – 27, 2018

organized by
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- **Monday, April 23, 2018**
  11:00 Victor Gurarie (U Boulder)
  Quantum particles in a random potential in high dimensions

  It is well known that quantum particles when moving in a random potential may undergo Anderson localization transition. It has only recently become appreciated that in high enough dimensions a different transition may happen. It manifests itself in the singular disorder averaged density of states as the disorder strength is tuned to the value corresponding to this transition point, and in multifractal wave functions. A particle obeying Schrdinger equation has to be above four dimensions for this to happen, but for Dirac or Weyl particle this happens already in three dimensional space corresponding to the experimentally studied Weyl materials. For certain disordered ion chains this can happen already in one dimensional space. Some evidence in the literature points to this criticality being a sharp crossover instead of a genuine phase transition, but this issue has not yet been unambiguously resolved. I will discuss the theory behind these phenomena and existing open questions.

- **Tuesday, April 24, 2018**
  11:00 Stefan Floerchinger (U Heidelberg)
  Thermalization and fluid dynamics in high energy collisions

  The expanding quark-gluon plasma created by a high energy nuclear collision can be described by dissipative relativistic fluid dynamics. Somewhat surprisingly, signatures of collectivity and thermalization are also found in more elementary collisions such as proton-proton or electron-electron. I will review this physics and discuss in particular how local thermalization in an expanding QCD string can be understood as a consequence of entanglement.

- **Wednesday, April 25, 2018**
  11:00 Paul Fendley (U Oxford)
  Preserving Quantum Coherence

  Considerable effort is being made to develop new methods of preserving quantum coherence, i.e. enabling quantum effects to be maintained for times long enough to exploit them for computations. I will survey three such methods, all involving deep mathematics. One is to find systems where topological invariants such as Chern number protect certain quantum properties. Another is to exploit integrability, where the presence of many conserved quantities strongly constrains the dynamics. Still another is prethermalisation, where a recent theorem shows there is always an almost-conserved charge in systems where the dominant term in the Hamiltonian has integer eigenvalues. I will explain a specific example that combines aspects of all three: quantum spin chains with an edge strong zero mode.

- **Thurday, April 26, 2018**
  11:00 Sebastian Diehl (U Cologne)
  Probing the topology of density matrices

  Topological concepts in many-body physics are so mainly formulated for ground states of Hamiltonians so far. The mixedness of a quantum state is usually seen as an adversary to topological quantization of observables. For example, exact quantization of the charge transported in a so-called Thouless adiabatic pump is lifted at any finite temperature in symmetry-protected topological insulators. Here, we show that certain directly observable many-body correlators preserve the integrity of topological invariants for mixed Gaussian quantum states in one dimension. Our approach relies on the expectation value of the many-body momentum-translation operator, and leads to a physical observable, the 'ensemble geometric phase' (EGP), which represents a bona fide geometric phase for mixed quantum states, in the thermodynamic limit. In cyclic protocols, the EGP provides a topologically quantized observable which detects encircled spectral singularities ('purity-gap' closing points) of density matrices. While we identify the many-body nature of the EGP as a key ingredient, we propose a conceptually simple, interferometric setup to directly measure the latter in experiments with mesoscopic ensembles of ultracold atoms.

- **Friday, April 27, 2018**
  11:00 Andrea Gambassi (SISSA, Trieste)
  Dynamical transitions, universality, and chaos in prethermal states