MP 2: Quantum Information and Thermodynamics

Zeit: Montag 14:00–15:55 Raum: SFG 2010

Hauptvortrag MP 2.1 Mo 14:00 SFG 2010

Entanglement in topologically ordered systems: A quantum information perspective — •Norbert Schuch — Max-Planck-Institut für Quantenoptik, 85748 Garching, Germany

Topologically ordered systems exhibit a rich variety of unconventional phenomena, such as protected edge physics or excitations with exotic statistics, which are rooted in the complex global entanglement present in these systems. In my talk, I will show how quantum information concepts allow us to construct a succinct description of these systems which explicitly reveals the structure of their entanglement, termed Tensor Network States. I will illustrate the power of this description by two examples: First, I will show how it allows to construct an explicit and general holographic duality relating the entanglement properties of the bulk to the boundary physics of a system, and second, I will demonstrate its power in identifying topological spin liquids, elusive systems which do not order magnetically despite strong interactions yet exhibit global topological order.

10 min. break

MP 2.2 Mo 14:55 SFG 2010

Advances in Lie Systems-Theory for Quantum Dynamics: From Ensembles to Control Design — •Thomas Schulte-Herbrüggen[1], Ville Bergholm[1,2], Gunther Dirr[3], and Robert Zeier[1] — [1]Technical University of Munich (TUM) — [2]University of Helsinki — [3]University of Würzburg

Recently we showed that all Markovian quantum maps can be represented by Lie semigroups. Lie groups and Lie semigroups with their symmetries provide a unified framework to pinpoint the dynamic behaviour of closed and open quantum systems under all kinds of controls.

Here we give a Lie picture of ensemble control in terms of Lie-relatedness within semisimple Lie algebras.

We extend capabilities by combining coherent control with simplest noise controls. Particular light is shed on the limits of reachability under open-loop versus closed-loop control designs.

MP 2.3 Mo 15:15 SFG 2010

A geometric viewpoint on quantum control — •Davide Pastorello — University of Trento and TIFPA, Trento

Quantum mechanics can be geometrically formulated in a symplectic fashion on the projective space (as a Kähler manifold) constructed out from the Hilbert space of the considered quantum theory. Within such a framework quantum dynamics can be represented by the flow of a Hamiltonian vector field in analogy to classical mechanics.

In this talk I propose a new geometric approach to controllability of a n-level quantum system from the viewpoint of geometric structures, exploiting some tools of classical control theory. In particular the notion of the accessibility algebra of classical non-linear systems in affine form can be adapted to study quantum controllability within geometric Hamiltonian formulation of quantum mechanics. Moreover the controllability of a quantum system can be completely characterized in terms of Killing vector fields on the complex projective space w.r.t. Fubini-Study metric.

The talk is mainly based on the following paper: D. Pastorello, A geometric approach to quantum control in projective Hilbert spaces. Accepted for publication in Reports in Mathematical Physics (2016).

MP 2.4 Mo 15:35 SFG 2010

Thermodynamics of anisotropic changes of state — •Falk Koenemann — Im Johannistal 19, 52064 Aachen

The mechanics of solids theory was founded long before the discovery of the First Law of thermodynamics. Elastic deformation is by nature a change of the energetic state in the sense of the First Law; however, the form of the First Law found used in continuum mechanics is not correct. For example, it is not possible to define the work done by shear forces. Thermodynamics is commonly presented in scalars (P,V,T), which implies isotropic boundary conditions. It has been transformed into vector field form (f,r,T), using the theory of potentials (Koenemann 2008). For isotropic boundary conditions the two forms deliver identical results; but the vector field form permits to explore reversible changes of state under anisotropic boundary conditions. The new approach correctly predicts volume-constancy under elastic pure shear conditions, and dilatancy under simple shear (Poynting effect). It is found that an anisotropically loaded volume of bonded matter is constitutionally expanded due to the work done by the shear forces. The effect amounts to a hitherto unknown thermodynamic state function. It has only one sign, it is always positive. It explains why solids can break under any confining pressure. At the transition from reversible to irreversible behavior a bifurcation is predicted that causes the system to relax into one of two possible geometric configurations with opposite handedness. This bifurcation is the cause of turbulence, triggered by the irreversible resolution of the elastic potential.

Koenemann (2008) Int. J. Modern Physics B 22, 2617