MP 3: Quantenmechanik und Quanteninformation

Zeit: Dienstag 16:45–18:40 Raum: VMP6 HS B

Hauptvortrag MP 3.1 Di 16:45 VMP6 HS B

(Un-)decidable problems in quantum theory — •Michael Marc Wolf — Technische Universität München

In the talk I will review recent results on the (un-)decidability of problems in quantum many-body physics and quantum information theory. In both fields there is a natural integer limit that opens the door to undecidability of some of the central properties: the thermodynamic limit in quantum many-body theory and the large block-size limit in information theory. I will try to illuminate the thin line between computable and uncomputable and to illustrate possible physical consequences of unprovable properties.

10 Minuten Pause

MP 3.2 Di 17:40 VMP6 HS B

Quantum theory from questions — •Philipp Höhn[1] and Christopher Wever[2] — [1]Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences, Vienna, Austria — [2]Institute for Theoretical Particle Physics, Karlsruhe, Germany

In contrast to relativity, quantum theory has evaded a commonly accepted apprehension, in part because of the lack of physical statements that fully characterize it. In an attempt to remedy the situation, we summarize a novel reconstruction of the explicit formalism of quantum theory (for arbitrarily many qubits) from elementary rules on an observer's information acquisition. Our approach is purely operational: we consider an observer O interrogating a system S with binary questions and define S's state as O's "catalogue of knowledge" about S; no ontic assumptions are necessary. From the rules, one can derive, among other things, the state spaces, the unitary group, the von Neumann evolution and show that the binary questions correspond to Pauli operators. The reconstruction also offers new structural insights in the form of novel informational charges and informational complementarity relations which define the state spaces and the unitary group. This reconstruction permits a new perspective on quantum theory.

MP 3.3 Di 18:00 VMP6 HS B

Controlling a d-level atom in a cavity — •Michael Keyl — TU München, Fakultät Mathematik, 85748 Garching

In this talk we discuss quantum control theory for a d-level atom in a cavity. The atom is described by a Graph Γ with energy levels as vertices and edges e as allowed transitions. For each such e the atom interacts (via a Jaynes-Cummings like interaction term) with a different mode of the cavity. We consider controllability of the overall system (i.e. atom and cavity) under the assumption that all atom-cavity interactions can be switched on and off individually and that the atom itself is fully controllable. Our main tools are symmetry based arguments recently introduced for the discussion of the two-level case [M. Keyl, R. Zeier, T. Schulte-Herbrüggen, NJP 16 (2014) 065010]. The basic idea is to divide the control Hamiltonians into two sets. One which is invariant under the action of an Abelian symmetry group G and a second set which breaks this symmetry. We will discuss how the group G and its action are related to the graph Γ and its fundamental groupoid, and how these structure can be used to prove full controllability – at least if Γ is acyclic. For Graphs containing cycles the situation is more difficult and the universal covering graph has to be used. We demonstrate this, using the fully connected graph on three vertices as an example.

MP 3.4 Di 18:20 VMP6 HS B

Quantum control for a Jaynes-Cummings-Hubbard model — •Margret Heinze and Michael Keyl — Zentrum Mathematik, M5, Technischen Universität München, Boltzmannstraße 3, D-85748 Garching

We examine the control of a quantum system consisting of several two-level atoms with each atom interacting with a different mode of an electromagnetic field.

More precisely, the system is a Jaynes-Cummings-Hubbard model where each cavity contains an atom and a bosonic excitation that can tunnel to the neighbouring cavities. The interaction strengths can be time dependently tuned in order to achieve controllability.

We discuss if it is possible that every pure state can be reached from a given reference state (pure-state controllability). This analysis is lifted to the level of operators where each unitary has to be approximated with arbitrarily small error by a time evolution operator for appropriate control functions and finite time (strong controllability).

The challenge of this infinite dimensional control problem is met, by firstly examining the symmetries of the system. A finite dimensional block diagonal decomposition is obtained for the control Hamiltonians that obey an abelian symmetry and due to a cut-off finite dimensional Lie analysis can be applied. By then adding a Hamiltonian that breaks the symmetry pure state and strong controllability are examined, c.f. [Michael Keyl, Robert Zeier, Thomas Schulte-Herbrüggen. "Controlling several atoms in a cavity". New Journal of Physics 16.6 (2014): 065010].