MP 8: Quanteninformation und Kontrolle

Zeit: Mittwoch 14:00–16:10 Raum: HS 23

Hauptvortrag MP 8.1 Mi 14:00 HS 23

Quantum Marginals, Entanglement, and Symmetries — •Michael Walter — University of Amsterdam

Given a collection of local density matrices, are they compatible with a global state? This question is known as the quantum marginal problem and it is of import in several areas, ranging from quantum information and entanglement theory to quantum chemistry. In this talk, I will give an introduction to this problem and present an efficient algorithmic solution, which opens up the possibility for numerically studying quantum marginals in many-body systems and larger atoms or molecules. Our quantum-inspired algorithm is based on mathematical insight from invariant theory and I will sketch this surprising connection.

MP 8.2 Mi 14:40 HS 23

Exploring the Limits of Quantum Dynamics – I: Lie-Algebraic Frame and Recent Results — •Thomas Schulte-Herbrüggen[1], Frederik vom Ende[1], Gunther Dirr[2], and Michael Keyl[3] — [1]Technical University of Munich (TUM) — [2]University of Würzburg — [3]Free University of Berlin (FUB)

Quantum systems theory emerges from a rigorous Lie-theoretical framework for answering questions of "what one can do" with a given quantum dynamical system in terms of controllability, accessibility, reachability, stabilisability, and simulability. It thus describes both potential and limits of dynamical systems, e.g., in quantum technology.

The broad class of *bilinear quantum control systems* is of the form $\dot{X}(t) = -\big(i\,\mathsf{ad}_{H_0} + \Gamma + i\sum_j u_j(t)\mathsf{ad}_{H_j}\big)X(t)$, where the drift is governed by the system Hamiltonian H_0 and eventually a (Markovian) dissipator Γ, while the control Hamiltonians H_j are switched by (piecewise constant) amplitudes $u_j(t)$. The class thus comprises coherently controlled Schrödinger (or Liouville) equations of closed systems as well as controlled Markovian master equations of GKS-Lindblad form.

We symmetry-characterise this class of dynamical systems to explore "what one can do" and give recent examples taking the dynamics of closed or open systems to their (symmetry-induced) experimental limits.

10 Minuten Pause

MP 8.3 Mi 15:10 HS 23

Exploring the Limits of Quantum Dynamics - II: Markovian Reachability — •Frederik vom Ende[1], Gunther Dirr[2], and Thomas Schulte-Herbrüggen[1] — [1]TU Munich, 85748 Garching, Germany — [2]University of Würzburg, 97074 Würzburg, Germany

Which quantum states can be reached by coherently controlling n-level quantum systems coupled to a thermal bath in a switchable Markovian way?

Questions of this kind form a challenging problem class. For solving them, we combine recent extensions of majorization techniques and Lie-geometrical control theory. We give inclusion relations deduced from dissipative actions on diagonal forms of quantum states and their unitary orbits. The inclusions hold for temperatures $0 < T \leq \infty$, while exact bounds exist for $T = 0$ (amplitude damping) and unital noise (bit flip), the latter being a standard example of a "normal" channel. Moreover, one can structure the whole class of normal Lindblad generators in terms of reachability given full unitary control.

These techniques may also be useful in view of related thermalization problems.

MP 8.4 Mi 15:30 HS 23

Quantum control in infinite dimensions and Banach-Lie algebras — •Michael Keyl — Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, 14195 Berlin, Germany

In finite dimensions, controllability of bilinear quantum control systems can be decided quite easily in terms of the "Lie algebra rank condition" (LARC), such that only the system Lie algebra has to be determined from a set of generators. In this paper we study how this idea can be lifted to infinite dimensions. To this end we look at control systems on an infinite dimensional Hilbert space, which are given by an unbounded drift Hamiltonian H_0 and bounded control Hamiltonians $H_1, \ldots, H_N$. The drift H_0 is assumed to have empty continuous spectrum. We use recurrence methods and the theory of Abelian von Neumann algebras to develop a scheme, which allows to use an approximate version of LARC in order to check approximate controllability of the control system in question. Its power is demonstrated by looking at some examples. We recover in particular previous genericity results with a much easier proof. Finally several possible generalizations are outlined.

MP 8.5 Mi 15:50 HS 23

Entanglement properties of USp⊗USp symmetric states — •Zoltán Zimborás[1], Michael Keyl[2], Thomas Schulte-Herbrüggen[3], and Robert Zeier[4] — [1]Wigner Research Centre for Physics, H-1021 Budapest, Hungary — [2]Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, 14195 Berlin, Germany — [3]Technical University Munich, Department of Chemistry, Lichtenbergstrasse 4, 85747 Garching, Germany — [4]Adlzreiterstrasse 23, 80337 Munich, Germany

It is notoriously hard to calculate entanglement measures for generic states. From the beginning of entanglement theory, it has been therefore useful to consider examples of entangled states that are highly symmetric, since representation theoretic methods can then be used to greatly simplify the computations of the measures and the characterization of entanglement properties. In the present work, we continue this program by studying $\mathrm{USp}(2n)\otimes\mathrm{USp}(2n)$ symmetric states. This symmetry defines a two-parameter family of states in any $2n \times 2n$ dimensional bipartite Hilbert-space. The two free parameters are related by partial transposition in much the same way as isotropic and Werner states, but unlike those states the studied family also contains a region with bound entangled states. Using group theoretical methods, we calculate the one-distillability and two-shareability regions for this set of states, and discuss how these might shed new light on some old conjectures.