MP 5: Quantum information

Time: Wednesday 11:00–12:30 Location: MP-H5

Invited Talk MP 5.1 Wed 11:00 MP-H5

Falling through masses in superposition: quantum reference frames for indefinite metrics — Anne-Catherine de la Hamette[1,2], Viktoria Kabel[1,2], Esteban Castro-Ruiz[3], and •Caslav Brukner[1,2] — [1]Institute for Quantum Optics and Quantum Information, Vienna, Austria — [2]Faculty of Physics, University of Vienna, Vienna, Austria — [3]Institute for Theoretical Physics, ETH Zürich, Zürich, Switzerland

The current theories of quantum physics and general relativity on their own do not allow us to study situations in which the gravitational source is quantum. In my talk, I will propose a strategy to determine the dynamics of objects in the presence of mass configurations in superposition, and hence an indefinite spacetime metric, using quantum reference frame (QRF) transformations. Specifically, I will show that as long as the mass configurations in the different branches are related via isometries, one can use an extension of the current framework of QRFs to "quantum isometries" to change to a frame in which the mass configuration becomes definite. Assuming covariance of dynamical laws under quantum coordinate transformations, this allows to use known physics to determine the dynamics. I will apply this procedure to find the motion of a probe particle and the behavior of clocks near the mass configuration, and thus find the time dilation caused by a gravitating object in superposition.

MP 5.2 Wed 11:30 MP-H5

Exploiting Graph Symmetries for Quantum Dynamics — Armin J. Römer[1,2], Emanuel Malvetti[1,2], Robert Zeier[3], and •Thomas Schulte-Herbrüggen[1,2] — [1]Technical University of Munich (TUM) — [2]Munich Centre for Quantum Science and Technology (MCQST) and Munich Quantum Valley (MQV) — [3]Forschungszentrum Jülich GmbH, Peter Grünberg Institute, Quantum Control (PGI-8)

Systems of coupled spins can easily be represented by coloured graphs, where the vertices relate to the local spins while the edges stand for pairwise couplings of different type (colour). Potential graph symmetries then naturally simplify quantum dynamics in terms of generators.

We present the background for an efficient algorithmic way to exploit the graph symmetry for arriving (automatically) at a symmetry-adapted basis. It avoids explicit calculation of the entire underlying graph automorphism groups (usually taking the form of wreath products of permutation groups). It connects the well-known Weisfeiler-Leman algorithm (occurring in the context of graph isomorphism problems) with cutting-edge versions of calculating central and orthogonal idempotents.

Worked examples illustrate principles and practice as well as the advantageous connections to graph theory in a widely applicable manner.

MP 5.3 Wed 11:50 MP-H5

Markovian Quantum Systems with Full and Fast Hamiltonian Control — •Emanuel Malvetti[1,2], Frederik vom Ende[1,2], Thomas Schulte-Herbrüggen[1,2], and Gunther Dirr[3] — [1]Dept. Chem., TU-München (TUM) — [2]Munich Centre for Quantum Science and Technology (MCQST) and Munich Quantum Valley (MQV) — [3]Institute of Mathematics, Universität Würzburg

Markovian quantum systems with full and fast Hamiltonian control can be reduced to an equivalent control system on the eigenvalues of the density matrix describing the state. First we consider the case of a single qubit, presenting explicit solutions of the optimal control problem for a large family of Lindblad operators. For the cases where analytic solutions seem out of reach, we can still efficiently compute numerical solutions. Second we consider quantum systems of arbitrary finite dimension. While analytic solutions to optimal control problems do not exist in the general case, the reduced control system on the eigenvalues is still a powerful tool. As an example, we derive necessary and sufficient conditions for a Markovian quantum system to be coolable.

MP 5.4 Wed 12:10 MP-H5

On the Alberti-Uhlmann Condition for Unital Channels — Sagnik Chakraborty[1], Dariusz Chruściński[1], Gniewomir Sarbicki[1], and •Frederik vom Ende[2,3] — [1]Institute of Physics, Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus University, Grudziadzka 5/7, 87-100 Toruń, Poland — [2]Department of Chemistry, Technische Universität München, 85747 Garching, Germany — [3]Munich Centre for Quantum Science and Technology & Munich Quantum Valley, Schellingstr. 4, 80799 München, Germany

We address the problem of existence of quantum channels between two sets of density matrices. We refine the result of Alberti and Uhlmann and derive a necessary and sufficient condition for the existence of a unital channel between two pairs of qubit states which ultimately boils down to three simple inequalities.