SYPS 1: PhD - Symposium: Optimal Control Theory in the Leading Domains of Quantum Technology

Time: Monday 14:00–16:00 Location: U Audimax

Invited Talk SYPS 1.1 Mon 14:00 U Audimax

Optimal control of many-body quantum systems — •Simone Montangero — Physics and Astronomy department "G. Galilei", Padova University, Italy.

Quantum optimal control allows finding the optimal strategy to drive a quantum system in a target state. We review an efficient algorithm to optimally control many-body quantum dynamics and present an information theoretical analysis of quantum optimal control processes and its implications.

We optimally control many-body systems to achieve an optimal quantum annealing process that goes beyond the adiabatic strategy. Finally, we review some theoretical and experimental applications of optimal annealing to different quantum simulation setups, ranging from the control of Rydberg atoms in optical lattices to the optimal crossing of the Superfluid to Mott insulator quantum phase transition.

Invited Talk SYPS 1.2 Mon 14:30 U Audimax

Light matter quantum interface based on single colour centres in diamond — •Fedor Jelezko — Institute of Quantum Optics, Ulm University, Ulm, Germany

Efficient interfaces between photons and atoms are crucial for quantum networks and enable nonlinear optical devices operating at the single-photon level. In this talk I will highlight properties of single color centers at low temperatures and show that single SiV and GeV color centers in diamond are promising candidates for creating such interfaces. I will also show experiments towards realization of fully integrated, scalable nanophotonic quantum devices.

Invited Talk SYPS 1.3 Mon 15:00 U Audimax

Principles of Quantum Systems Theory and Control Engineering — •Thomas Schulte-Herbrüggen — Technical University of Munich (TUM), Germany

We exemplify system-theoretical principles and tools by analysing systems following an extended Lindblad master equation. The extensions incorporate coherent and incoherent controls and make the dynamics take the form of a (bilinear) control system thus setting the frame for the tutorial.

In this picture, a Quantum Noether-type Theorem naturally arises and relates symmetries to fixed points. It allows for symmetry assessment of *controllability* in closed systems and, analogously, *accessibility* in open Markovian systems—both in a unified frame.

By recent examples we illustrate how breaking system symmetries with the help of numerical optimal control then paves the way to exploiting the full quantum potential of experimental set-ups pertinent in quantum engineering and emerging technologies.

Invited Talk SYPS 1.4 Mon 15:30 U Audimax

Quantum metrology with Rydberg atoms — •Sebastien Gleyzes[1], Arthur Larrouy[1], Remi Richaud[1], Sabrina Patsch[2], Jean-Michel Raimond[1], Michel Brune[1], and Christiane Koch[2] — [1]Laboratoire Kastler Brossel, College de France, CNRS, ENS-Universite PSL, Sorbonne Universite, 75231 Paris, France — [2]Theoretical Physics, University of Kassel, Heinrich-Plett-Straße 40, 34132 Kassel, Germany

Rydberg atoms are extremely sensitive to their electromagnetic field environment, which make them a very promising tools for metrology. Rydberg atoms can be described by the model of the hydrogen atom. By applying a small static electric field, it is possible to partially lift the degeneracy between same n levels. The new sublevel forms a regular structure. It is possible to manipulate the state of the atom using a rf field with a well-defined polarization to prepare states with large electric or magnetic dipole. In our experiment, we generate Schrödinger cat states of the Rydberg atom of rubidium by preparing quantum superposition of two trajectories with very different classical property. The relative phase of the superposition is very sensitive to the variations of the probe environment, which allows us to measure electric or magnetic field with a very good sensitivity. However, the preparation fidelity is limited by the actual energy structure of rubidium, which is much more anharmonic than that of hydrogen. I will show how implementing RF pulse shape that have been optimized by the University of Kassel using Optimal Control Theory allowed us to drastically improve the efficiency of our pulses.