A 21: Poster – Atomic Systems in External Fields

Time: Wednesday 17:00–19:00 Location: Philo 1. OG

A 21.1 Wed 17:00 Philo 1. OG

Revealing emergent many-body phenomena by analyzing large-scale space-time records of monitored quantum systems — •Marcel Cech[1], Cecilia De Fazio[1], María Cea[2,3], Mari Carmen Bañuls[2,3], Igor Lesanovsky[1,4], and Federico Carollo[5] — [1]Universität Tübingen, Tübingen, Germany — [2]Max-Plank-Institut für Quantenoptik, Garching, Germany — [3]Munich Center for Quantum Science and Technology (MCQST), München, Germany — [4]University of Nottingham, Nottingham, United Kingdom — [5]Coventry University, Coventry, United Kingdom

Recent advances in quantum simulators permit unitary evolution interspersed with locally resolved mid-circuit measurements. This paves the way for the observation of large-scale space-time structures in quantum trajectories and opens a window for the *in situ* analysis of complex dynamical processes. We demonstrate this idea using a paradigmatic dissipative spin model [1], which can be implemented, e.g., on Rydberg quantum simulators. Here, already the trajectories of individual experimental runs reveal surprisingly complex statistical phenomena. In particular, we exploit free-energy functionals for trajectory ensembles to identify dynamical features reminiscent of hydrophobic behavior observed near the liquid-vapor transition in the presence of solutes in water. We show that these phenomena are observable in experiments and discuss the impact of common imperfections, such as readout errors and disordered interactions.

[1] M. Cech, *et al.*, arXiv:2507.00944 (2025)

A 21.2 Wed 17:00 Philo 1. OG

Interaction between Poincaré light and atoms — •Shreyas Ramakrishna[1,2] and Stephan Fritzsche[1,2] — [1]Helmholtz Institute Jena, Germany — [2]Friedrich-Schiller University Jena, Germany

This poster discusses the physics underlying the interaction between a Poincaré beam and an optically polarized atomic medium in the presence of a constant magnetic field. Our investigation reveals that the absorption profile of the Poincaré beam exhibits axial asymmetry. This asymmetry depends sensitively on the relative orientation of the pump and probe light fields with respect to the quantization axis, as well as on the strength of the magnetic field. To illustrate these findings, we choose the incoming radiation drives an electric dipole transition, $F_g = 1$ to $F_e = 0$ in rubidium atoms subjected to various magnetic field strengths.

A 21.3 Wed 17:00 Philo 1. OG

Suppression and revival of Floquet-Feshbach resonances — •Louisa Marie Kienesberger, Alexander Guthmann, Felix Lang, Vicente Baca, David Lang, Eleonora Lippi, and Artur Widera — RPTU University

Resonant scattering is a central concept in physics, providing a powerful tool on interaction dynamics from nuclear reactions to ultracold quantum gases. In ultracold atomic systems, magnetically tunable Feshbach resonances enable precise and flexible control over interaction strengths. Recently, we demonstrated that Floquet engineering of two-body interactions via periodically modulated magnetic fields enables the creation of additional, tunable Feshbach resonances [1].

In this contribution, we investigate the behaviour of these Floquet-Feshbach resonances as a function of the modulation strength and identify a characteristic Bessel-function dependence, where the order of the Bessel function corresponds to the order of the Floquet-Feshbach resonance. These Bessel functions define how the widths and amplitudes of the individual Floquet-Feshbach resonances vary with modulation amplitude and frequency, providing a simple handle to enhance or suppress specific resonances. Furthermore, these studies offer insight into Floquet-induced scattering dynamics and support the tailored control of atomic interactions required for quantum simulations of complex many-body systems and the exploration of exotic quantum phases.

[1] A. Guthmann, F. Lang, L. M. Kienesberger, S. Barbosa, and A. Widera, Floquet engineering of Feshbach resonances in ultracold gases, Science Advances 11, eadw3856 (2025).

A 21.4 Wed 17:00 Philo 1. OG

Mechanical squeezed Kerr oscillator based on a tapered ion trap — Bogomila Nikolova[1], Moritz Gob[2], Kilian Singer[2], and •Peter Ivanov[1] — [1]Sofia University, Bulgaria — [2]University of Kassel, Germany

We propose a theoretical description of a mechanically squeezed Kerr oscillator with a single ion in a tapered trap. We show that the motion coupling between the axial and radial modes caused by the trap geometry leads to Kerr nonlinearity of the radial mode with magnitude controlled by the trap frequencies. This allows the realization of non-Gaussian quantum gates, which play a significant role in the universal set of continuous variable quantum gates. Furthermore, we show that, because of the nonlinearity of the ion trap, applying an off-resonant time-varying electric field along the trap axis causes a motion squeezing of the radial mode. Finally, we discuss the motion mode frequency spectrum of an ion crystal in a tapered trap. We show that the frequency gap between the motion modes increases with trap nonlinearity, which benefits the realization of faster quantum gates.

A 21.5 Wed 17:00 Philo 1. OG

High-fidelity multistate Stimulated Raman adiabatic passage via parallel eigenenergies — •Julian K. Dimitrov and Nikolay V. Vitanov — Center for Quantum Technologies, Department of Physics, Sofia University, James Bourchier 5 blvd., 1164 Sofia, Bulgaria

We present a new approach to high-fidelity multistate Stimulated Raman adiabatic passage (STIRAP). Techniques that optimize multistate STIRAP have been proposed before and they require using additional (shortcut) fields. Here we propose an optimization which does not require additional fields but pulse shaping only. The optimization is based upon the concept of quasi-parallel eigenenergies, which are known to suppress nonadiabatic transitions between two states. It is shown analytically how the parallelization criterion imposes certain time-dependent pulse shapes of the driving fields. Similar to parallel three-level STIRAP, proposed earlier, the parallel multistate STIRAP is robust to errors in the driving fields and the detunings while leaving the intermediate states unpopulated in the adiabatic limit. Moreover, this improvement of fidelity does not require prohibitively large pulse areas. We manage to enhance the STIRAP fidelity by up to 5 orders of magnitude thereby making multistate STIRAP suitable for quantum information processing. We anticipate applications in atomic clocks and atom optics.