A 8: Atomic systems in external fields

Time: Tuesday 16:30–18:30 Location: P

A 8.1 Tue 16:30 P

Numerical Studies of atom-based microwave eletric field sensing in hot vapors — •Matthias Schmidt[1], Fabian Ripka[1], Chang Liu[1], Harald Kübler[1,2], and James P. Shaffer[1] — [1]Quantum Valley Ideas Laboratories, 485 Wes Graham Way, Waterloo, ON N2L 6R1, Canada — [2]5. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, D-70569 Stuttgart, Germany

We present progress in atom-based microwave electric field sensing using Rydberg atoms in hot vapors. We find two distinct strategies to detect the electric field strength of the RF wave, namely the Autler-Townes limit, where the splitting of the dressed states is proportional to the incident RF electric field strength and the amplitude regime, where we determine the electric field by measuring the difference of transmission in the presence of the microwave. We present a simplified theoretical model where we consider the small microwave intensity as an induced detuning of the coupling laser. With this model we can analytically investigate the main contribution to the transmission signal and find a simple relation between the change of the transmission and the incident RF electric field strength. Furthermore we present a three photon excitation scheme, with which residual Doppler broadening is suppressed. This enables a spectral resolution comparable to the Rydberg state decay rate, the spectral bandwith limitation.

A 8.2 Tue 16:30 P

Interaction of atoms with cylindrically polarized Laguerre-Gaussian beams — •Shreyas Ramakrishna[1,2,3], Jiri Hofbrucker[1,2], and Stephan Fritzsche[1,2,3] — [1]Helmholtz Institute Jena, Frobelstieg 3, D-07749 Jena, Germany — [2]GSI Helmholtzzentrum fur Schwerionenforschung GmbH, Planckstrasse 1, D-64291, Germany — [3]Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universitat Jena, Max-Wien-Platz 1, D-07743 Jena, Germany

The excitation of atoms with a single valence electron by cylindrically polarized Laguerre-Gaussian beams is analyzed within the framework of first-order perturbation theory. For cylindrically polarized Laguerre-Gaussian beams, we show that the magnetic components of the electric-quadrupole field varies significantly in the beam cross-section with beam waist and radial distance from the beam axis. Furthermore, we discuss the influence of varying magnetic components of the electric-quadrupole field in the beam cross-section on the sublevel population of a localized atomic target. In addition, we calculate the total excitation rate of electric quadrupole transition (4s $^2S_{1/2}$ - 3d $^2D_{5/2}$) in a mesoscopic target of Ca^+ ion. Our calculation shows that the cylindrically polarized Laguerre-Gaussian beams are more efficient in driving electric quadrupole transition in the mesoscopic atomic target than circularly polarized beams.

A 8.3 Tue 16:30 P

Quadrupole transitions with continuous dynamical decoupling — •Víctor José Martinez Lahuerta[1], Lennart Pelzer[2], Ludwig Krinner[2], Kai DIetze[2], Piet Schmidt[2], and Klemens Hammerer[1] — [1]Institute for Theoretical Physics and Institute for Gravitational Physics (Albert-Einstein-Institute), Leibniz University Hannover — [2]Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany

Continuous dynamical decoupling provides a powerful method to protect decoherence on atomic transitions due to magnetic field fluctuations or electric quadrupole shifts. Here, we analyze the structure of the effective basis under one and two layers of continuous dynamical decoupling. We use this to characterize quadrupole transitions among dynamically decoupled, dressed states, as relevant for ion clocks. Additionally, we characterize effective selection rules and Rabi frequencies.

Finally, this is applied to a quadrupole transition in Ca+ showing accordance with experimental results.

A 8.4 Tue 16:30 P

Quantum Mpemba Effect in simple spin models — •Simon Kochsiek, Federico Carollo, and Igor Lesanovsky — Institut für Theoretische Physik, Universität Tübingen, Auf der Morgenstelle 14, 72076 Tübingen, Germany

In the context of both classical and quantum out-of-equilibrium systems the characteristic time scale that is needed to reach stationarity is of central importance. In particular, if properties of the steady state are to be exploited, the relaxation time is the central hurdle and metastable regions become problematic. In a recent work [1] it was shown that the (quantum) Mpemba Effect provides a way of preparing the initial state of the dynamics such that its overlap with slowly decaying modes is minimized.

We investigate the quantum Mpemba Effect in simple spin systems. While the transformation which annihilates the overlap with the slowest decay mode is difficult to implement practically, we show, that even simple product transformations can lead to a significant speed-up of relaxation. Furthermore we explore the connection between system size and interaction strength with the achievable amount of acceleration.

[1] F. Carollo *et al.*, Phys. Rev. Lett. **127**, 060401 (2021)