Stuttgarter Physikalisches Kolloquium

Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
Max-Planck-Institut für Intelligente Systeme

Ansprechpartner: Prof. Harald Giessen
E-Mail: giessen@physik.uni-stuttgart.de
Telefon: 0711 - 685-65111

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Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart-Vaihingen

Gastgeber: Prof. Dr. Tilman Pfau, Universität Stuttgart, Telefon: 0711 - 685-68025

Highly Excited Atoms as Resources for Quantum Technologies

James P. Shaffer
Quantum Valley Ideas Laboratories, Waterloo, Canada

Abstract

Highly excited Rydberg atoms have exaggerated properties that can be controlled through state selection since these properties can scale strongly with principal quantum number, *n*. Rydberg state properties such as large transition dipole moments and polarizability can be used for quantum technologies, where the unique features of quantum phenomena are exploited for applications in areas like sensing, communications and computing. The well-known Rydberg atom blockade phenomena is an example where the large polarizability of a Rydberg state leads to long range interactions that enable the collective excitation of atoms. In this talk, we describe another example of using Rydberg atoms for quantum technology. We report on experiments where Rydberg atoms are used for sensing radio frequency electric fields in the gigahertz to terahertz regime. In this work, Rydberg atoms have been shown to be the most sensitive absolute electric field sensors discovered to date and are currently being developed as a new standard for electric field strength in this frequency regime. Fundamental limits to the sensitivity of the Rydberg atom-based RF electric field sensing will be addressed. Depending on the spectral resolution of the read-out, either the RF induced transmission line frequency splitting, the Autler-Townes regime, or a change in the on-resonant absorption, the amplitude regime, can be used to determine the RF electric field. We will also present theoretical results of a 3-photon read-out scheme which enables the Autler-Townes regime of Rydberg atom-based RF electrometry to be extended to lower RF electric field strengths. We show that the residual Doppler shifts can be reduced and signal strengths increased using the approach.