SYAW 1: Awards Symposium

Time: Wednesday 14:30–16:00 Location: C/gHS

Prize Talk SYAW 1.1 Wed 14:30 C/gHS

Warum einzelne kalte Atome? — •Peter E. Toschek — Institut für Laser-Physik, Universität Hamburg, Hamburg, Germany — Laureate of the Herbert-Walther-Prize

Während vieler Jahrzehnte bezogen sich die meisten Beobachtungen im Bereich der Quantenphysik auf große Gesamtheiten. Nebel- und Blasenkammerspuren oder Szintillations-Signale ließen jedoch nur post-mortem-Beobachtungen zu. Die Präparation individueller kalter Atome erlaubte erstmals wiederholbare Messungen an einem mikroskopischen quantenmechanischen System in Echtzeit(1,2). Solche Messungen verschaffen Einblicke in die Quanten-Dynamik(3,4) und ein tieferes Verständnis der Quanten-Messung(5,6). Sie sind auch eine Voraussetzung für die Quanten-Informationsverarbeitung.

(1) Optical sideband cooling of visible atom cloud confined in parabolic well, W. Neuhauser, M. Hohenstatt, P.E.T., H. Dehmelt. Phys.Rev.Lett. 41, 233 (1978)

(2) Localized visible Ba+ mono-ion oscillator, W. Neuhauser, M. Hohenstatt, P.E.T., H. Dehmelt. Phys.Rev. A 22, 1137 (1980)

(3) Observation of quantum jumps, Th. Sauter, W. Neuhauser, R. Blatt, P.E.T. Phys.Rev.Lett. 57, 1696 (1986)

(4) Measurement-induced vibrational dynamics of a trapped ion, B. Appasamy, Y. Stalgies, P.E.T. Phys.Rev.Lett. 80, 2805 (1998)

(5) Single-atom interferometry, R. Huesmann, Chr. Balzer, Ph. Courteille, W. Neuhauser, P.E.T. Phys.Rev.Lett. 82, 1611 (1999)

(6) Decoherence in generalized measurement and the quantum Zeno paradox, G.Mack, S. Wallentowitz, P.E.T. Physics Reports 540, 1 (2014)

Prize Talk SYAW 1.2 Wed 15:15 C/gHS

Strongly interacting Rydberg gases in thermal vapor cells — •Tilman Pfau — Universität Stuttgart — Laureate of the Gentner-Kastler-Prize

Rydberg atoms are of great interest due to their prospects in quantum information processing. Coherent control of the strong Rydberg-Rydberg interaction allows for the realization of quantum operations and devices such as quantum gates and single-photon sources. This impressive experimental progress has been limited to the ultracold domain. Being able to exploit this interaction in a coherent manner in thermal vapor would eliminate the need for cooling and trapping of atoms and thus offer new prospects for integration and scalability.

We present our progress on the coherent control and investigation of Rydberg atoms in small vapor cells. We drive Rabi oscillations on the nanosecond timescale to a Rydberg state by using a pulsed laser excitation and are therefore faster than the coherence time limitation given by the Doppler width.

A systematic investigation reveals a clear signature for a strong van der Waals interaction between Rydberg atoms. The strength of the interaction exceeds the energy scale of thermal motion (i.e. the Doppler broadening) and therefore enables many body quantum physics at or above room temperature. As an example we observe evidence for aggregate formation of Rydberg atoms in a vapor cell.

Besides this we have demonstrated electric field sensing applications and have shown that coherent Rydberg excitation is also possible in vapor filled photonic crystal fibers. Several applications from THz sensing to single photon sources seem within reach.