Strongly interacting Rydberg gases in thermal vapor cells

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Rydberg atoms are of great interest due to their prospects in quantum information processing[1]. 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. To date, impressive experimental progress has been limited to the ultracold domain [2]. 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 show that we are able to 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 [3].

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 above room temperature [4]. As an example we observe evidence for aggregate formation of Rydberg atoms in a vapor cell [5].

Besides these many body physics phenomena also electric field sensing applications have been demonstrated [6] and recently it was shown that coherent Rydberg excitation is also possible in photonic crystal fibers [7].

Several applications from THz sensing to singe photon sources seem within reach.

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