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Rydberg-Rydberg interactions in ultracold atomic gases SEBASTIAN HOFFERBERTH, JONATHAN BALEWSKI, STEPHAN JENNEWEIN, ALEXANDER KRUPP, HUAN NGUYEN, JOHANNES NIPPER, MICHAEL SCHLAGMUELLER, CHRISTOPH TRESP, ROBERT LOEW, TILMAN PFAU, University of Stuttgart — The giant size and large polarizibility of Rydberg-atoms make them ideal to study many-body collective effects. We present recent results from the ultra-cold Rydberg experiments in our group. Firstly, we discuss studies of Förster resonances, which appear when two-body-states are tuned into resonance. The resulting strong dipolar interatomic interactions vary in strength and angular dependency based on the magnetic substates involved. We study these interactions in a Ramsey atom interferometer, where the two interferometer arms are atoms in the ground and in the Rydberg state. Using this phase sensitive tool, Förster resonances are studied with unprecedented accuracy. The coherent technique enables to resolve several resonances and study their coherence properties. Secondly, we present our new setup for studying single Rydberg-excitations in optical traps smaller than the Rydberg-blockade sphere. Such ensembles, where all trapped atoms coherently share a single Rydberg-excitation, form a two-level "superatom" whose Rabi-oscillation is collectively enhanced. Our new apparatus combines single ion-detection, sub-micron optical resolution, and highly flexible optical trapping potentials to study coherent dynamics of individual superatoms as well as interactions between superatoms.

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