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Atom-molecule coherence and Ramsey interferometry in ultracold Rydberg gases ROBERT LOEW, University of Stuttgart, JONATHAN BALEWSKI, JOHANNES NIPPER, BJOERN BUTSCHER, TILMAN PFAU, UNIVERSITY OF STUTTGART, GERMANY TEAM — Ultralong-range Rydberg molecules are bound states of a Rydberg atom with ground state atoms [1]. We report on experiments studying the coherence properties of this new class of molecular bond. We demonstrate the coherent transfer of initially free pairs of rubidium ground-state atoms to ultralong-range Rydberg molecules using rotary echo and Ramsey-pulse sequences. The coherent evolution of the molecular system is characterized by measuring the timescales for the energy-conserving dephasing rate, T2, and for non-energy-conserving decay processes, T1 [2]. Furthermore, these Ramsey experiments can be viewed as an atom-molecule interferometer where the unbound ground state atoms and the ultalong-range Ryberg molecules form two branches. The relative phase in the arms of such an interferometer can be precisely controlled and varied over a wide range using additional electric field pulses. Besides this proof of principle, this technique provides a phase sensitive tool to measure interactions between Rydberg atoms or molecules.

[1] V. Bendkowsky et al., Nature 458, 1005 (2009)
[2] B. Butscher et al., Nature Physics, nphys1828 (2010)

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