A single Rydberg impurity coupled to a Bose-Einstein condensate

Robert Löw, Kathrin Kleinbach, Felix Engel, Florian Meinert and Tilman Pfau

5. Physikalisches Institut, Pfaffenwaldring 57, University of Stuttgart, Germany

Atoms prepared in highly excited Rydberg states constitute remarkable quantum objects with extreme properties. Among others, the electronic wavefunction may extend over mesoscopic distances easily reaching the micrometer scale. In our experiment, we explore single Rydberg impurities immersed in a Bose-Einstein condensate (BEC), for which thousands of groundstate atoms lie within the Rydberg wavefunction. Based on detailed spectroscopic studies of electron-neutral scattering in the ultracold, we report on the current status of our endeavor to employ the interaction of the Rydberg electron with the condensate atoms to imprint the Rydberg wavefunction onto the BEC density. In combination with high resolution optical addressing and readout, we aim for direct imaging of Rydberg orbitals.

[1] M. Schlagmüller, T. C. Liebisch, F. Engel, K. S. Kleinbach, F. Böttcher, U. Hermann, K. M. Westphal, A. Gaj, R. Löw, S. Hofferberth, T. Pfau, J. Perez-Rios, and C. H. Greene, Phys. Rev. X **6**, 031020 (2016).