Few- and many-body physics with ultracold dipolar quantum gases

Content

Since the first realization of a Bose-Einstein condensate in 1995, the research field of ultracold atomic gases rapidly progressed and has proven to be an ideal testbed for e.g. the investigation of various few- and many-body phenomena, the realization of new and exotic quantum phases, and the implementation of quantum simulation protocols. In recent years, the emergence of magnetic atoms - in particular from the lanthanide series - opened up new and novel opportunities due to the complexity of their electronic structure and their large magnetic moment, realizing long-range interacting quantum matter. Here, we will present our results on the investigation of few- and many-body physics using ultracold dipolar quantum gases made of erbium and dysprosium. Starting with the scattering properties of single species and mixtures [1,2,3,4,5], we will continue to discuss the excitation spectrum and its rotonization [6,7]. Finally we show that beyond-mean-field effects allow to prepare liquid-like self-bound droplets and explore the phase diagram where the long-sought supersolid state - featuring superfluidity and a spatially periodic structure at the same time - connects those independent droplet phase with the regular BEC phase [8,9,10,11].

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