AKjDPG 2: Tutorial: Dipolar Gases

Time: Sunday 17:00–18:30 Location: HS 3044

Tutorial AKjDPG 2.1 Sun 17:00 HS 3044

Experiments with Ultracold Quantum Gases of Magnetic Atoms — •Lauriane Chomaz — Physikalisches Institut, Universität Heidelberg, Im Neuenheimer Feld 226

Ultracold quantum gases provide a pristine platform to study few-body and many-body quantum phenomena with an exquisite degree of control. The achievement of quantum degeneracy in gases of atoms with large magnetic dipole moments in their electronic ground states has opened new avenues of research in which long-range anisotropic dipole-dipole interactions play a crucial role. In this one-hour introductory lecture, I will give an overview of the magnetic quantum gas experimental platform and of the recent discoveries based on this platform [1]. Magnetic quantum gases allow easy access to ultracold temperature and quantum degeneracy in many-particle systems, and provide a wide variety of tuning knobs, in particular over the interaction competition and the gas confinement geometry. Fine control of this interaction competition and gas geometry has led in recent years to the discovery of novel many-body quantum states, including liquid-like droplets, droplet crystals, and supersolids, a paradoxical phase of matter that simultaneously exhibits solid and superfluid orders. I will highlight current research directions and prospects opened up by these discoveries and the increasing level of control.

[1] L. Chomaz, I. Ferrier-Barbut, F. Ferlaino, B. Laburthe-Tolra, B. L. Lev, and T. Pfau, Dipolar physics: a review of experiments with magnetic quantum gases, Rep. Prog. Phys. 86, 026401 (2023).

Tutorial AKjDPG 2.2 Sun 17:45 HS 3044

Theoretical modelling of dipolar quantum gases — •Thomas Bland — Universität Innsbruck, Institut für Experimentalphysik, Innsbruck, Austria

Since the first observation of a Bose-Einstein condensate (BEC) made from strongly magnetic atoms, these systems have proven to be a rich source of new and fascinating phenomena arising from the long-range and anisotropic dipole-dipole interaction. In this tutorial, I will introduce the underlying theoretical models of these systems; ranging from mean-field theories for bulk gases that predict, for example, the existence of the supersolid phase, to many-body theories for atoms trapped in optical lattices, where the long-range interactions introduce a plethora of new quantum phases with links to a broad range of condensed matter and solid-state systems.