Many-body quantum phases in ultracold dipolar gases

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In the last decades, ultracold atomic gases proved to be an ideal platform for simulating many-body quantum phenomena thanks to the ability of adding complexity in a controlled way. Recently, ultracold gases made of magnetic atoms brought to the discovery of new phenomena and exotic states of matter arising from the long-range and anisotropic dipole-dipole interactions, as roton modes and supersolidity [1].

We present here the latest results from our dipolar quantum gas experiment, which uniquely combines two highly magnetic atomic species, erbium (Er) and dysprosium (Dy) [2]. Our quantum mixture merges for the first time the field of heteronuclear mixtures with the one of ultracold dipolar gases. After the investigation of their interspecies interactions [3], we proved two-dimensional supersolidity with dysprosium [4], paving the way to the study of vortices, persistent currents, and phases with exotic geometry.

As a future step in the experiment, we present our concept for quantum gas microscopy of dipolar systems, designed to manipulate the two species at the single-atom level within a highly-controlled magnetic field environment, where complex phases arising from the spontaneous orientation of the dipoles can appear.

References

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Figures

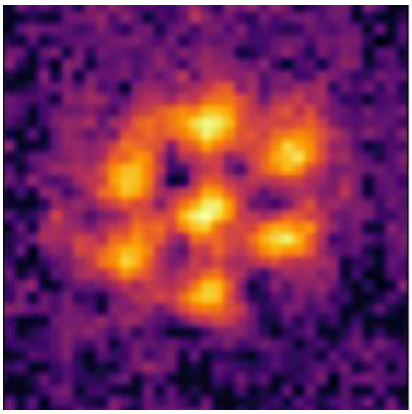

Figure 1: Experimental realization of two-dimensional supersolidity with dysprosium atoms