Competing interactions in dipolar erbium atoms

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Ultracold magnetic atoms exhibit short-range contact interactions together with long-range dipole-dipole interactions. The competition between these two interactions gives rise to various quantum phases [1], where the usually dominant mean-field interactions are small and the system is governed by quantum fluctuations [2].

In this talk, I will first report on the study of a supersolid state and its excitation spectrum [3]. In such a state, two symmetries are spontaneously broken: the gauge symmetry, associated with the phase coherence of a superfluid, and the translational invariance, signalizing crystalline order. As a result, two distinct branches appear in the excitation spectrum, one for each broken symmetry.

In the second part of the talk, we add a one-dimensional optical lattice to the system and create a platform, in which quantum fluctuations are still unexplored and a variety of new phases may be observable. We employ Bloch oscillations as an interferometric tool to assess the role that quantum fluctuations play in an array of quasi-two-dimensional Bose-Einstein condensates [4]. We observe a transition to a state localized into a single lattice site and purely driven by interactions. Finally, we uncover the parameter regimes where both droplet and soliton states can be achieved.

References

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