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【514】Quantum Simulation with Ultracold Dipolar Atoms

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Quantum simulations open the path for understanding complex quantum matter. Among the large variety of possible approaches, ultracold quantum gases offer a skilful realization of models in condensed matter physics from the weakly to the strongly correlated regime. The key benefits lie on in the ability to reach a high degree of isolation and state control, to change the system's dimensionality, and to engineer the interaction between particles. So far, the large majority of realized systems employed ultracold atomic species with dominant contact interactions. However, recently highly magnetic species established themselves as novel powerful resources in the quantum realm thanks to their long-range and anisotropic dipole-dipole interaction.
Today, the quest for dipolar quantum simulators marks one of the latest developments in the rapidly evolving field of quantum gases. This talk will present an overview of our latest developments, from the first realizations of quantum-degenerate dipolar gases and mixtures of erbium and dysprosium, to the observation of novel quantum-fluid phenomena such as roton excitation and supersolid phases and the realization of strongly correlated many-body quantum systems of increased complexity. For magnetic atoms confined in light crystals, we will show how the large spin nature of our magnetic atoms and the long-range character the interaction remove the restriction of on-site interaction and allow to process extended Hubbard-type Hamiltonians with extra spin degrees of freedom.

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