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From Few-Body to Many-Body Physics in Ultracold Gases of Magnetic Dipolar Atoms.

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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 anisotropic and long-range interactions play a crucial role. In my talk I will present related experimental findings in gases of open-shell lanthanide atoms, in particular erbium and dysprosium. I will discuss intriguing aspects of the few-body scattering of these atoms and show how this leads to the emergence of exotic many-body effects. The complex atomic structure of these atoms leads not only to large interatomic dipole-dipole interactions, but also to complex short-range scattering with a dense spectrum of Feshbach resonances. The tunable competition between short- and long-range interactions has allowed the discovery of novel stable many-body states where interaction effects beyond the mean field are crucial. These new phases include liquid-like droplets, droplet crystals, and supersolids, a paradoxical phase of matter that simultaneously exhibits solid and superfluid orders. After reviewing the experimental work of the past few years, I will outline perspectives for future research.

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