Progress towards the realization of a quantum degenerate dipolar gas of dysprosium atoms

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Long-range interactions, such as Coulomb interaction between electrons and dipolar interaction between magnetic spins, govern the behavior of many physical systems. A controlled experimental environment to study quantum effects of long-range interactions is therefore of general interest. Quantum gases with strong magnetic dipolar interactions offer the possibility to study paradigm systems that can lead to better understand some physical mechanisms of real matter and possibly to engineer new materials. Moreover, the ability to hold them in the ordered environment provided by an optical lattice opens the way to studies of strongly-correlated systems in different dimensionalities.

We plan to realize a quantum gas of dysprosium atoms to perform quantum simulations of strongly-correlated dipolar systems. Contrary to alkali atoms, usually employed in cold atoms experiments, dysprosium has the largest magnetic dipole moment, 10 Bohr magnetons, among all elements. For this reason, besides interacting via van der Waals interaction, which has substantially a contact nature, Dy atoms also interact via dipole-dipole magnetic interaction, which is both long-range and anisotropic. The combination of these two ingredients leads to the appearance of peculiar quantum phenomena so far only barely explored [1]. Moreover, Dy isotopes, with both fermionic and bosonic nature, can be brought to quantum degeneracy [2,3], allowing statistics-dependent studies.

The actual state of the experiment at INO will be described. An effusive beam of dysprosium atoms has been slowed by a laser beam on the stronger blue resonance at 421 nm in a Zeeman slower. The weaker resonance line at 626 nm will be used to implement a magneto-optical trap. Using laser cooling on that narrow line transition, the trapped Dy atoms will be at a temperature low enough to be efficiently loaded into a dipole trap and successively evaporated to degeneracy.

References

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