Dipolar Chromium BECs and magnetism

Bruno Laburthe-Tolra[1]

[1] *Université Paris-Nord XIII*

Abstract

Bose-Einstein condensates (BECs) made of 52Cr atoms reveal new phenomena, due to relatively strong dipole-dipole interactions. For example, in a Cr BEC, the long-ranged and anisotropic dipolar interactions lead to an elongation of the BEC along the axis of the dipoles [1], a modification of collective excitations [2], and an anisotropic speed of sound [3].

In this talk, I will focus on the effect of dipolar interactions on the properties of multi-component (spinor) Cr condensates at very low magnetic fields. Due to its anisotropy, the dipole interaction introduces magnetization-changing collisions, which frees the magnetization of the gas. We have thus observed a demagnetization of the BEC when the magnetic field is quenched below a critical value Bc corresponding to a phase transition between a ferromagnetic and a nonpolarized ground state. The phase transition is due to an inter-play between spin-dependent interactions and the linear Zeeman effect [4]. We have also studied the thermodynamic properties of spinor Cr atoms, and we have observed that above Bc, the ferromagnetic nature of BECs leads to the spontaneous magnetization of the cloud when BEC is reached [5].

I will also describe the control of magnetization-changing collisions in optical lattices. We investigate a scheme in which dipolar relaxation is resonant when the energy released in dipolar relaxation matches a band excitation resonance [6]. This scheme, which may produce correlated pairs of rotating states in each lattice site, can be viewed as the equivalent of the Einstein-de-Haas effect. Although rotation is not yet produced in our experiment, I will present first experimental results of these dipolar resonances, which show a pronounced anisotropic behaviour.

References

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