Tuning e□ective magnetic dipolar interactions in Rb spinor condensates

S. Palacios[1], S. Coop[1], T. Vanderbruggen[1], N. Martinez[1], and M.W. Mitchell[1,2]

[1] *ICFO- The Institute of Photonic Sciences, Carl Friedrich Gauss 3, 08860 Castelldefels (Barcelona), Spain*
[2] *ICREA - Institució Catalana de Recerca i Estudis Avancats, 08015 Barcelona, Spain*

Presenting Author: silvana.palacios@icfo.es

We describe our progress towards the all optical formation of a spinor condensate of Rb atoms in a quiet magnetic environment with residual fields < 10 pT. Under such an environment the Zeeman energy is overshadowed by the weak magnetic dipole-dipole interaction (MDDI) energy of Rb: the interplay between MDDI and spin dependent contact interaction (SDCI) determines the ground state magnetization of the magnetic superfluid. The long range nature of MDDI couples the external and internal degrees of freedom, making the magnetization depends on the geometry of the confining trap. By changing the trap shape it is possible to explore di□erent phase transitions that appear in the absence or presence of magnetic fields and gradients, and e□ectively tune the MDDI as shown in Fig. 1 [1].

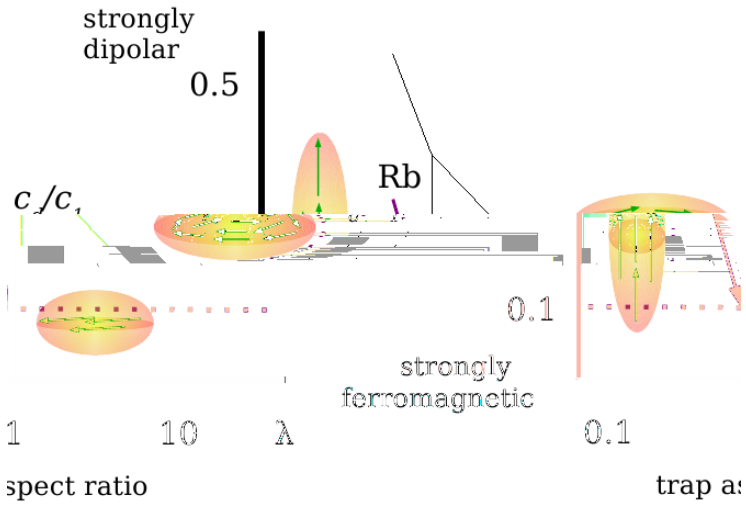

Figure 1: *Phase diagram of dipolar spin-1 ferromagnetic condensates in the $c_d/c_1 - \lambda$ space where c_d/c_1 is the ratio between MDDI and SDCI strengths (about 0.1 for Rb) and λ the trap aspect ratio.*

We confine ^{87}Rb atoms in a dipole trap at 1560 nm formed by three crossing Gaussian beams. This trap induces not only a trapping potential but also a large di□erential light-shift between the ground state $5^2S_{1/2}$ and the excited state $5^2P_{3/2}$ (D2 line) due to strong contributions to the polarizability of the excited state through the $5^2P_{3/2} - 4D_{3/2,5/2}$ transitions at 1529 nm. This light-shift is spatially dependent like the intensity distribution of the Gaussian beams, we exploit this e□ect in the characterization of the trap geometry. The magnetic field environment is actively controlled by compensating the fields measured by fluxgate detectors (noise < 10 pT) around the vacuum chamber. By evaporating cooling we will condense atoms occupying the F=1 ferromagnetic ground state and by changing the relative powers and waists of the dipole beams we will change the trap geometry.

References

[1] S. Yi, H. Pu Phys. Rev. Lett. 97, 020401 (2006)