Master Internship Position

High-resolution imaging of ultracold samples of atomic Dysprosium

Laboratory

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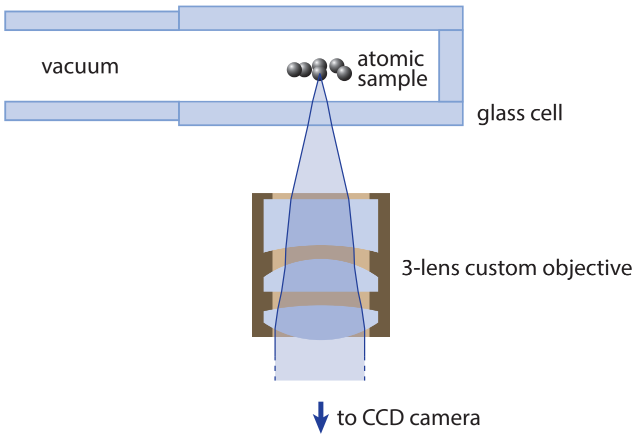

FIGURE 1 – *Schematics of the high resolution imaging system. We will design a custom microscope objective made of three optical elements. We aim at a diffraction-limited imaging resolution of 0.6* μm*, which can be achieved with a numerical aperture of 0.4, and taking into account the refraction effects by the vacuum glass cell. We will also maximize the field of view over which the resolution is maintained, in order to cover the typical size of atomic samples (10 to 100* μm*).*

Scientific context

Since the observation of Bose-Einstein condensation in 1995, the research field of ultracold atomic gases expanded towards the study of various types of complex quantum systems. Among them, the so-called topological states of matter – for which the 2016 Nobel prize in physics was awarded to J. M. Kosterlitz, D. Haldane and D. J. Thouless – recently attracted a lot of efforts, due to the very exciting and peculiar physical behaviors expected in such systems, such as the possible occurrence of anyons, which are quasi-particles that exhibit neither a bosonic nor fermionic quantum statistics.

Our experiment, which produces ultracold samples of atomic Dysprosium, aims at realizing topological phases of matter. The simulation of artificial gauge fields is the basic ingredient leading to such exotic phases of matter. They can be induced by dressing the atoms with lasers fields, and Dysprosium is one the most promising choice of atom, given its specific atomic spectrum with narrow optical transitions.

Internship project

The experimental setup was built over the last 3 years, and we now routinely produce ultracold samples of Dysprosium. The internship will be devoted to the construction of a high-resolution imaging system, based on the analysis of the absorption of resonant laser light. We will design a custom-made lens system allowing for a spatial resolution below 1 μm. We will characterize it experimentally using small-scale physical objects, before implementing it on the experiment. We will also develop a model to design single-atom sensitive imaging in future experiments, based on the imaging of the atom fluorescence. We also expect the intern to be involved on the main experiment.

The internship can be followed by a PhD, which will be devoted to the study of artificial gauge fields and topological states of matter with atomic Dysprosium.