A cesium interferometer for quantum metrology

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The matter-wave properties of atoms and the macroscopic behavior of Bose-Einstein condensates (BECs) make interference experiments with ultracold atoms a useful tool for metrology applications. It has been shown that a condensate can be split while controlling the relative phase, realizing a phase-preserving beam splitter. [1] Utilizing this method, high sensitivity to small energy differences can be achieved with BEC interferometry. [2] The procedures developed in the past years lead to the prospect of an integrated matter-wave sensor for high-precision measurements. [3]

In order to realize such a sensor we are building an experimental setup for cesium interferometry. Cesium atoms are first laser-cooled in two magneto-optical trap phases (2D+ and 3D). Bose-Einstein condensation of cesium has been attained by tuning the scattering properties in an optical trap. [4] Our setup allows for trapping and condensing an atomic cloud in a dipole trap close to the surface of an atomchip (Fig. 1).

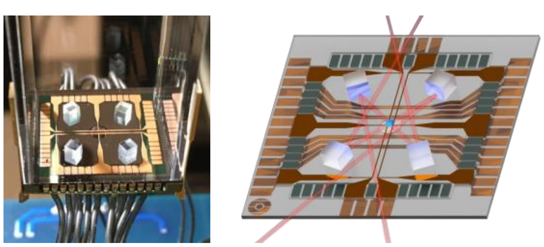

Fig. 1: Bottom view of the atomchip.

Once a BEC is achieved, the single potential well is continuously deformed into a double well, where the relative phase between the two resulting clouds needs to be highly reproducible. Depending on their energy difference – arising from atomic interactions and inhomogeneities of ambient fields – the two condensates now accumulate a phase difference. As we aim at exceptionally high sensitivity, this phase accumulation time must be rather long. This we intend to accomplish by reducing the scattering length of the ultracold atoms via magnetically induced Feshbach resonances and by shielding the experiment against external influences.

Our setup is based on a commercial RuBECi system by ColdQuanta (*www.coldquanta.com*), consisting of a double-chamber glass cell with cesium dispensers, the magnets and coils necessary for laser-cooling and trapping atoms, and the atomchip itself. Besides the advantage of a compact device allowing for easy control of the various parameters, this is expected to grant us rapid progress compared to home-built devices requiring plenty of optimization.

The poster presentation will feature the main objectives and prospects as well as the current status of the experiment. It will also discuss the systematic energy budget to evaluate the challenges and constraints given by ambient and control fields.

Keywords: ATOM INTERFEROMETRY, CESIUM BEC, QUANTUM METROLOGY

References

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