

Atom-chip based quantum gravimetry with Bose-Einstein condensates

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Today's inertially sensitive atom interferometry devices operate mostly with sources of laser cooled atoms. The finite temperature and size of these sources limit the efficiency of employed beam splitters and the analysis of systematic uncertainties. These limits can be overcome by the use of ultracold sources such as a delta-kick collimated Bose-Einstein condensate (BEC) with extremely narrow velocity distribution. Atom-chip technologies offer the possibility to generate a BEC and perform delta-kick collimation in a fast and reliable way. We show a combination of such an ensemble generated in a miniaturized atom-chip setup with the application of Bragg beam splitting to perform inertially sensitive measurements. A specialty of this setup is that the beam splitting light field, which forms a Mach-Zehnder interferometer (MZI), is reflected at the atom chip itself. In this way, the chip is serving as the inertial reference inside the vacuum, allowing for a very compact prototype of a quantum gravimeter that is capable of determining the local gravitational acceleration. With the help of an optical lattice in combination with a double Bragg diffraction pulse we developed a novel coherent relaunch technique in a retro-reflected optical lattice and implemented a fountain geometry where the atomic ensemble is coherently relaunched on a parabolic trajectory. This allows us to increase the intrinsic sensitivity of the employed MZI by a factor of twenty, while keeping the region, in which the whole sequence is realized, as compact as a cube with one centimeter side length below the atom chip.