in microgravity

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A new field in matter wave optics is emerging, which is based on very long baseline atom interferometry (VLBAI). These interferometers strive to increase the sensitivity by coherently spitting and separating wave packets over macroscopic spatial and temporal scales. Bose-Einstein condensates, representing a textbook example for a macroscopic wave packet, are the ideal source for performing this kind of interferometry and were exploited for the first time in the extended free fall for this kind of experiments with a chip-based atom laser for Rubidium □□Rb. By adiabatic opening the magnetic trap, we can generate atomic samples with an energy corresponding to 15 nK. With the help of delta kick cooling, implemented via the atom chip, we can further slow down the expansion and achieve temperatures around a nK and less. In addition, the chip allows to transfer atoms in the individual Zeeman states of the two Hyperfine groundstates, in particular into the non-magnetic state. With this toolbox we could extend the observation of an interfering BEC of only 10000 atoms to macroscopic time scales approaching two seconds. Benefiting form the extended free fall in microgravity we could combine this with an assymetric Mach-Zehnder type interferometer over hundreds of milliseconds to study the coherence and to analyse the delta kick cooling with the help of the observed interference fringes. This experiment can be considered as a gigantic double slit experiment in microgravity. A novel generation of atom chips allows to improve the performance of these flexible devices. We could demonstrate loading of the chip with far more than 10□ atoms in roughly a second in a setup of the size of a shoebox. We discuss as a possible spin-off a chip based quantum gravimeter for ground based applications, recently demonstrated with our device. The design is employed for a rocket based test of such an interferometer and will demonstrate the feasibility of a satellite based tests of Einsteins principle of equivalence as pursued by the STE-QUEST mission.

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