Atomic strontium based inertial sensor with micron spatial resolution

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Alkali-earth atoms have an electronic level structure particularly suited for applications in matter-wave interferometry and high-precision laser spectroscopy. Recently atomic strontium was the subject of active research in several fields such as all-optical cooling towards quantum degeneracy [1] and detection of ultra-narrow optical transitions[2]. Because of its small elastic cross-section[3], we show that ultra-cold ^{88}Sr in presence of a lattice potential is also particularly well suited for the realization of inertial sensors to accurately measure forces with micro-metric spatial resolution. By loading the sample into a vertical lattice potential we observe persistent Bloch oscillations with a damping time longer than 10 seconds[4], and from the measured Bloch frequency we determine the local gravity with a sensitivity of $5 \times 10^{-6} g$. Our result has direct implications in force measurements at small distances from surfaces such as tests of possible deviations form the Newtonian gravity potential at sub-millimetre distances.
We will present the status of a force measurement at distances below 20 μm from dielectric and metallic surfaces, which based on ultra-cold atoms undergoing Bloch oscillations.

We will also report on the progress towards the realization of an optical frequency standard based on the highly forbidden $^1S_0$-$^3P_0$ ^{88}Sr intercombination line at 698 nm as well as the realization of a laser suited for precision spectroscopy on this transition.

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