ATOMIC STRONTIUM FOR QUANTUM SENSORS, ULTRACOLD ATOMIC PHYSICS AND PRECISION SPECTROSCOPY

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Alkali-earth atoms have an electronic level structure particularly suited for ap- plications 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 measure forces on few microns length scale. 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 5×10^{-6}g. Our result has direct implications in force measurements at small distances such as testing possible deviations form the Newtonian gravity potential at submillimeter distances and, in this direction, we started the study on test masses specically designed to highlight this deviation. Preliminary force measurements at distances shorter than 100 microns form dielectric surfaces will be presented. We will also report on the production of isotope mixtures of ultracold Sr,[5] and 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.

[1]H. Katori, T. Ido, Y. Isoya, and M. Kuwata-Gonokami, PRL 82, 1116 (1999)
[2]M. Takamoto, F.-L. Hong, R. Higashi, H. Katori, Nature 435, 321 (2005)
[3]G. Ferrari, R. E. Drullinger, N. Poli, F. Sorrentino, G. M. Tino, PRA 73, 023408 (2006)
[4]G. Ferrari, N. Poli, F. Sorrentino, G. M. Tino, submitted to PRL, ArXiv:physics/0605018.
[5]N. Poli, R. E. Drullinger, G. Ferrari, J. Lonard, F. Sorrentino, and G. M. Tino, PRA 71, 061403(R) (2005)