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Ultrasensitive Ultra Cold Atom Gradiometer, from capability demonstrations in laboratory to space missions

Sébastien Merlet, Mehdi Langlois, Azer Trimeche, Carlos Garrido Alzar, and Franck Pereira dos Santos
LNE-SYRTE, Observatoire de Paris, PSL Research University, CNRS, Sorbonne Universités, UPMC Univ. Paris 06, Paris, France (sebastien.merlet@obspm.fr)

Atom interferometry allows for the realization of a generation of instruments for inertial sensing based on laser cooled atoms. Lastest advances permit fast preparation of Ultra-Cold Atom sources to nK temperatures. Moreover, more robust and more powerful lasers are now available. New atom interferometers taking advantage of these progresses will lead to development of the next generation of inertial sensors, with new geometries exploring new capabilities.
In this framework, we have started to develop a gradiometer measuring the Earth vertical gravity gradient. It combines :
1- two ultra-cold sources obtained with on chip magnetic traps,
2- powerful lasers to drive the atoms.
These two key points will be combined to realise interferometers based on multi-photonic beam splitters of hundreds of hk (instead of 2hk previously) in a fountain configuration. For a cycling time of 2 s, the expected differential sensitivity is 1.3×10-11 g with 1 s of measurement for a detection limited by the quantum projection noise. As the two clouds will be separated by 1 m, this will lead to a sensitivity on the vertical gradient, of 126 mE with 1 s of measurement in the laboratory.
I will present the instrument under development and its status, and will extend to space mission. Indeed, without gravity, the interferometer time parameter can be much more longer. For example, if the interferometer time is increased by a factor of 10, a sensitivity of 2 mE with 1 s of measurement can be obtained.