# Pushing the limits of an atom gravimeter


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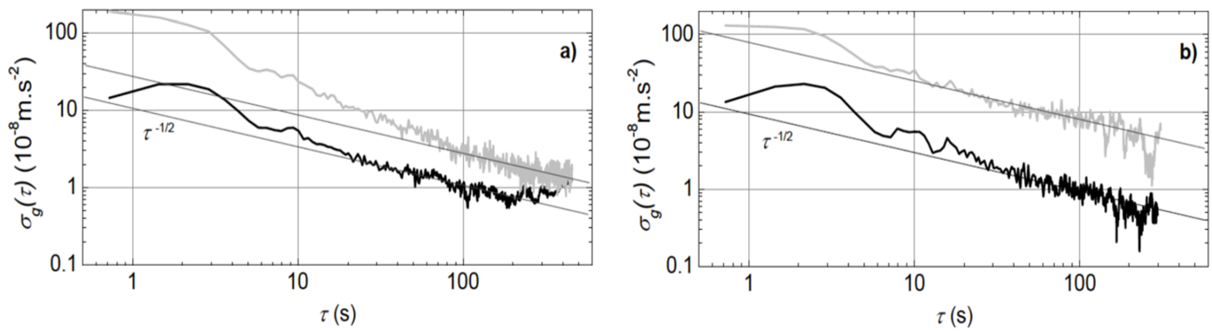
In the frame of the watt balance project of the Laboratoire National de Métrologie et d'Essai (LNE) [1] which aims to participate to the new definition of the kilogram, the SYRTE (SYstèmes de Références Temps et Espace) has developped a cold atom absolute gravimeter. The principle of measurement is based on atom interferometry [2]: during its free fall, a cold sample of $^{87}$Rb atoms undergoes three vertical laser pulses which split each atomic wave packet into two states of different momentum, then redirect and recombine them. The phase difference between the two arms of the interferometer is then proportional to the local gravity g. With only two-photon recoil momentum transfer induced by Raman transition, our device has reached an accuracy of $5.10^{-9}$g and a sensitivity of $2.10^{-8}$g after one second of averaging, which are similar to the state-of-art optical gravimeters. Moreover our instrument is the only mobile atom gravimeter to participate to international comparisons.




*Allan standard deviations obtained at LSBB with isolation platform (a) and without (b). Black curves: gravity sensitivities when post correcting from ground vibrations. Gray curves represent the sensitivities of the associated seismometer signals. $\tau^{1/2}$ slopes correspond to a white noise.*

The current performances of our gravimeter are limited in one hand by vibrational noise, on the other hand by systematics linked to the transverse velocity of atoms and an insufficient control of their position (wavefront aberrations). For the first reason, we moved it into a low-noise underground laboratory (LSBB), which allowed to achieve the best short term sensitivity ever obtained without any – usually essential - ground vibration isolation system: $10^{-8}$m.s$^{-2}$ in 100s measurement time. For the second reason, after an advanced study of velocity distribution has been done, we are installing an all-optical evaporation system in order to have a better evaluation of the wavefront aberration bias with colder atoms.


References:

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