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Towards the nano-g with a cold atom gravimeter

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Absolute gravity value is requested in several domain, from geophysics to metrology with the implementation of the kilogram. Since 2003, SYRTE has developed a state-of-the-art cold atom gravimeter (CAG), based on atom interferometry technics. It uses free-falling ^{87}Rb atoms, which experience a sequence of two-photons Raman pulses driven by counter-propagating vertical lasers. The atom interferometer phase shift is proportional to g, the Earth gravity acceleration that the CAG measured with a sensitivity better than conventional state of the art absolute gravimeters ($5.7 \cdot 10^{-8}$ m $\cdot$ s^{-2} in 1 s of measurement, down to $5 \cdot 10^{-10}$ m $\cdot$ s^{-2} after 10 000 s) and more accurately ($2 \cdot 10^{-8}$ m $\cdot$ s^{-2}). Limits are dominated by wave-front aberrations and the cold atom source initial position fluctuations. Several improvements will be made to reach the 10^{-10} range both in term of accuracy and stability. For this purpose, the gravimeter moved from gravimetry reference station at LNE to Observatoire de Paris in 2021.
In this presentation, I will present the experiment, briefly remind its history to then focus on our current work. I will detail some biases and their evaluation and will focus specifically on the two-photon light shift. Finally, I will talk about an attempt to improve the interferometer contrast with optimal control of Raman pulses, which led us to study to the mid pulse interferometer Raman pulse, supposed to have no effect on the measurement.

Orateur: M. PESCHE, Maxime (SYRTE)