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Operating an industry-grade quantum differential gravimeter

Camille Janvier[1], Vincent Ménoret[1], **Jean Lautier**[1], Bruno Desruelle[1], Sebastien Merlet[2], Franck Pereira dos Santos[2], and Arnaud Landragin[2]

[1]Muquans, Talence, France (jean.lautier@muquans.com)

[2]LNE-SYRTE, Observatoire de Paris, Université PSL, CNRS, Sorbonne Université

After three years of development in collaboration with LNE-SYRTE, we report on the development, the integration and the preliminary operation of an industry-grade absolute differential gravimeter. This new generation of instrument goes beyond the possibilities offered by existing gravity gradiometers, as one differential gravimeter measures simultaneously g and the vertical gradient of g [1]. Relying on atom interferometry with cold 87 Rb atoms, a single vertical laser beam simultaneously measures the vertical acceleration experienced by two sets of laser-cooled atoms free-falling from different heights. For each drop, the half-sum of the two vertical accelerations gives access to g and the half-difference to dg / dz. As far as technology is concerned, our differential gravimeter relies on a physical principle and a set of technologies that have already been validated for absolute quantum gravimeters [2].

Our demonstrator is operational since November 2019 and has shown the ability to run continuously for more 18 days without any human attendance. We will present in detail the experimental results for the measurement of g and dg / dz. Regarding the measurement of the vertical gradient of g, we obtain a short-term sensitivity of 76 E/√t (1E = 10 -9 s -2 = 0.1 µGal/m) and a resolution of a 4 E when data is averaged over 1000 s. Regarding the measurement of g itself, we obtain a short-term sensitivity of 36 µGal/√t and a resolution of a few µGal when data is averaged over 500 s. These are preliminary results and options and future plan to improve the sensitivity and the stability of the measurements will be discussed.

Such quantum differential gravimeter is to our knowledge the only technology that allows for an absolute continuous drift-free monitoring of simultaneously gravity and gravity gradient over timescales from a few minutes to several months.

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[1] R. Caldani *et al.*, "Simultaneous accurate determination of both gravity and its vertical gradient", Phys. Rev. A **99**, 033601 (2019)

[2] V. Ménoret *et al.*, "Gravity measurements below 10−9 g with a transportable absolute quantum gravimeter", Nature Scientific Reports, vol. 8, 12300 (2018)