Contribution ID: **63** Type: **parallel**

Searching for variations of fundamental constants and dark matter using an atomic clock ensemble

Tuesday, 13 September 2016 14:00 (30 minutes)

The ratio of two atomic transition frequencies is by definition independent of the unit of frequency and therefore its value depends only on fundamental constants such as the fine-structure constant α or fundamental properties of particles like for instance the electron mass. Repeated measurements of frequency ratios performed in the laboratory, with suitable atomic structure calculations, are therefore a direct test of the present-day stability of fundamental constants with respect to space-time and, via the motion of the Earth, gravitational potential. Such tests are independent from any cosmological models and complementary to astrophysical tests.

At LNE-SYRTE we operate an ensemble of atomic clocks both in the microwave (hyperfine transition in the ground state of ^{133}Cs and ^{87}Rb) and in the optical part of the spectrum ($1S_0$ - $3P_0$ in ^{87}Sr and ^{199}Hg) providing for several atomic frequency comparisons [1]. In this talk we will report more specifically on highly accurate Rb/Cs hyperfine frequency comparisons performed with atomic fountains over more than 15 yr. They provide stringent limits on possible time variations of a particular linear combination of constants, or its coupling to gravity, involving α and the quark mass scaled to the chromodynamics mass scale [2]. The results also constitute a stringent differential redshift test for the Rb/Cs couple. Besides, they provide improved constraints on the coupling of a putative massive scalar dark matter field to standard matter [3]. We will also present repeated accurate measurements of the Sr/Cs and Hg/Cs frequency ratios which complement similar measurements performed in other laboratories, and for the first time, measurements of Sr/Rb and Hg/Rb frequency ratios which are sensitive to other linear combinations of constants [4][5].

[1] M. Abgrall *et al.*, C.R. Physique 16, 461-470 (2015)

[2] J. Guéna *et al.*, Phys. Rev. Lett. 109, 080801 (2012)

[3] A. Hees et *al.*, submitted, available at arXiv:1604.08514 (2016)

[4] Le Targat et al., submitted, available at arXiv:1605.03878 (2016)

[5] R. Tyumenev et al., submitted, available at arXiv:1603.02026 (2016)

Summary

Primary author: GUÉNA, Jocelyne (Observatoire de Paris)

Co-authors: Dr HEES, Aurélien (University of California); Dr LODEWYCK, Jérôme (Observatoire de Paris); Dr DE SARLO, Luigi (Observatoire de Paris); Dr ABGRALL, Michel (Observatoire de Paris); Dr WOLF, Peter (Observatoire de Paris); Dr LE TARGAT, Rodolphe (Observatoire de Paris); Dr BIZE, Sébastien (Observatoire de Paris); Dr LECOQ, Yann (Observatoire de Paris)

Presenter: GUÉNA, Jocelyne (Observatoire de Paris)

Session Classification: [VC-E] Varying constants –laboratory experiments