Post-doc researcher position

Subject: Microcell-based optical clocks
Duration : 1 year, with possibility of extension

The interrogation of an atomic vapor in a mm-scale micro-fabricated cell has led along the last 20 years to the development of high-precision chip-scale atomic devices [1], including in particular the demonstration of low-power consumption and ultra-stable miniature atomic clocks [2]. These clocks, now commercially-available, offer a frequency stability at the level of 10^{-10} at 1 s and about 10^{-11} at 1 day integration time, in a volume of about 15 cm^3 and a power consumption of 150 mW [3-4].

Despite remarkable performances, these miniature atomic clocks present limitations including (a) a clock transition frequency in the microwave domain of "only" about 10 GHz (b) a laser with high FM noise that can limit the clock short-term stability and (c) the presence of buffer gas in the cell that induces a clock frequency shift that can limit the clock long-term stability.

In response, an extremely stimulating approach consists of the development of next-generation microcell-based optical clocks [5-7]. These miniatuirized optical frequency references consist to stabilize the frequency of a high-spectral purity laser onto an optical atomic resonance detected in a high-purity alkali micro-fabricated vapor cell. Such clocks target frequency stability performances about 1000 times higher than current chip-scale atomic clocks, while conserving a modest size and power consumption.

At FEMTO-ST, we work on the development of microcell-based optical clocks. A first demonstrator is based on the frequency stabilization of a 895 nm laser onto a Cs microcell using dual-frequency sub-Doppler spectroscopy [8]. Other studies are starting by using the two-photon transition of Rb atom at 778 nm [5,6]. Numerous metrological and technological studies remain to be performed to push these clocks to their ultimate performances. The candidate will be fully involved on this research topic and will contribute to the progress of this strategic activity at FEMTO-ST. The candidate will contribute to the implementation of lab-prototype microcell based optical clocks and to their metrological characterization, in particular for its frequency stability.

The candidate will integrate the team-project "Miniature cell clocks" at FEMTO-ST, involving members of the OHMS group (http://teams.femto-st.fr/equipe-ohms/) [Time-Frequency Dpt] and members of the MOSAIC group (https://teams.femto-st.fr/MOSAIC/en) [Micro-Nano Sciences and Systems Dpt]. The team-project in which the candidate will evolve is currently composed of 3 researchers, 1 postdoc and 4 PhD students. The candidate will benefit from the support of electronics/mechanics/computing services at FEMTO-ST and of an infrastructure devoted to time-frequency metrology (http://oscillator-imp.com/dokuwiki/doku.php) and MEMS technologies (https://www.femto-st.fr/en/Platforms/MIMENTO-Presentation). The candidate will communicate results in scientific journals and international conferences.

The candidate has a PhD. The candidate should have a significant interest for applied physics sciences in general. Background with atomic clocks or sensors and metrology will be a strong plus-value. The candidate should enjoy working in a team group.

Application:
Requis : PhD thesis in physics / applied physics / engineering sciences
Start: From 1st september 2022
Duration : 1 year + 1-time extension possible
Salary: between 2500 and 3700 € (gross salary), depending on years of experience
Procedure: Aplpy on https://emploi.cnrs.fr/Offres/CDD/UMR6174-RODBOU-001/Default.aspx

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Références

[1] J. Kitching, Appl. Phys. Rev. 5, 031302 (2018)
[2] S. Knappe, MEMS atomic clocks, Comprehensive microsystems, 3, 571-612 (2007).
[3] https://www.microsemi.com/product-directory/clocks-frequency-references/3824-chip-scale-atomic-clock-csac
[4] https://www.syrlinks.com/fr/produits/all/temps-frequence/horloge-atomique-miniature-mmac
[5] Z. Newman et al, Optica 6, 5, 580 (2018).
[6] V. Maurice et al., Opt. Exp. 28, 17, 24708 (2020).
[7] A. Gusching et al., J. Opt. Soc. Am. B 38, 10, 3254 (2021)
[8] D. Brazhnikov et al., Phys. Rev. A 99, 062508 (2019).