A Ramsey-CPT microcell atomic clock using laser current pulsed modulation

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Microwave chip scale atomic clocks (CSACs) based on coherent population trapping (CPT) have achieved great success including their commercialization and deployment across a diverse range of applications[1].

A critical feature of CSACs is their long-term stability, known to be notably impacted by light-shifts effects. Several approaches have been proposed to address this problem in standard CSACs employing a continuous-wave (CW) interrogation technique[2,3]. However, these approaches are subject to some limitations and drawbacks[4].

An alternative technique used to mitigate light-shift effects in CPT clocks is to use pulsed Ramsey-based interrogation sequences[5]. Such methods have been recently applied in microcell clocks[6,7]. However, in these experiments, the Ramsey-CPT sequence was generated with an external acousto-optic modulator (AOM). Yet, the AOM is not compatible with a fully-integrated CSAC.

In this work, adapting a two-step pulse optical sequence[8], implemented with an FPGA-based digital board, we demonstrate a Ramsey-CPT microcell atomic clock using direct pulsed modulation of the laser current. Narrow and high-contrast Ramsey-CPT fringes are detected in a Cs-Ne microcell. The short-term fractional frequency stability is measured at $1.3 \times 10^{-10}\tau^{-1/2}$ until 2000 s. For $\tau > 2000\ s$, the stability is degraded. Main suspects are residual light-shifts and Ne permeation through the cell borosilicate glass windows[6].

The implementation of the symmetric autobalanced Ramsey (SABR) interrogation technique coupled with the use of a cell made of low-permeation glass windows is under progress for improved stability. Latest results will be presented at the conference.

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