Double-Modulation CPT clock based on hot cesium vapor cell

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In previous Hot Vapor Workshop 2018, the pulsed CPT clock was presenting the state-of-the-art frequency stability using a vapor cell with thermal cesium in a Argon-Nitrogen buffer gas mixture [1]. The atomic interaction was combining two orthogonal linear laser polarizations and a pulsed interrogation Ramsey technique in order to get a high contrast and narrow linewidth CPT resonance. In the experimental setup, the CPT interaction was driven by two phase-locked extended cavity diode lasers (ECDL) tuned to the cesium D1 line, and the pulsed CPT signal was detected as Ramsey fringes [2, 3].

Recent studies have lead to a continuous atomic clock design based on a double modulation coherent population trapping (DM-CPT) technique. In this technique we synchronously modulate the phase and the polarization of one bichromatic laser beam in order to trap more atoms in the so-called dark state, increasing the observed atomic signal. A best case short term frequency stability is reported at the level of $2.9 \times 10^{-13}\tau^{-1/2}$ up to 100 s averaging time. However, the white frequency noise is routinely limited to a few 10 s. The main limitation is the stability of the microwave power used to generate the bichromatic laser. We propose an original method to lock the microwave power using the AC Stark shift effect and improve the frequency stability by almost a factor 10 times after 1000 s. Mid term limitations are laser and microwave power, magnetic field and collisionnal effects through thermal variations.

These results are promising and demonstrate that the DM-CPT technique is well suited for the development of a high performance continuous atomic clock with a potential compact and robust design thanks to its linear architecture. This clock could find application in telecommunications, instrumentation or global navigation satellite systems.

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