Compact atomic clock based on coherent population trapping in a cesium vapor cell

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Compact and stable frequency standards are needed in many applications such as satellite navigation systems. Alkali-metal vapor-cell atomic clocks are used for this purpose currently. In the next generations, atomic clocks based on Coherent Population Trapping (CPT) offer a very interesting solution. Thanks to their high stability and simple architecture, they represent promising candidates for on-board applications.

The pulsed CPT clock presented here shows 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 combines two orthogonal linear laser polarizations and a pulsed interrogation Ramsey technique to get a high contrast and narrow linewidth CPT resonance. In practice, the CPT interrogation is driven by two phase-locked extended cavity diode lasers (ECDL) tuned to the cesium D1 line as shown on Figure 1 (left) and the pulsed CPT signal is detected as Ramsey fringes (right).

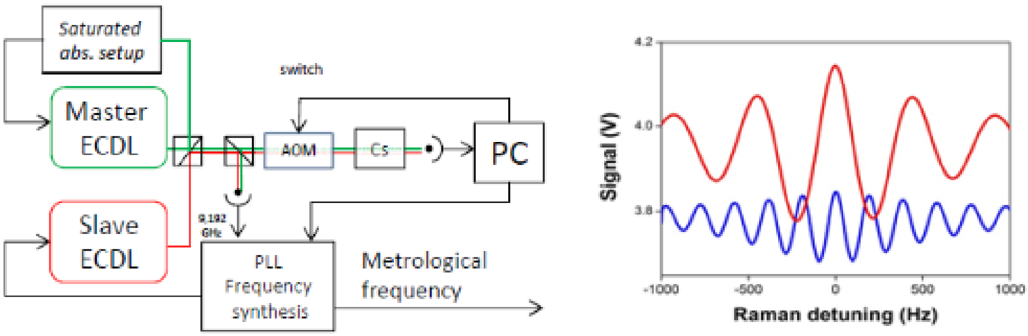

Figure 1. Left : Experimental setup showing the Master and Slave lasers servo-loop. Right : Experimental Ramsey fringes for 2 ms (upper red curve) and 5 ms interrogation time (lower blue curve).

The short term fractionnal frequency stability has been measured at the level of $2.3 \times 10^{-13}\tau^{-1/2}$ for a few hundreds seconds integration time. The main frequency noise sources are the optical intensity noise and the microwave phase noise [2, 3]. Mid term limitations are laser power, magnetic field and collisionnal effects.

[1] O. Kozlova et al., IEEE Trans. Instr. Meas., **63**, 7, 1863 (2014).
[2] J.-M. Danet et al., IEEE Trans. UFFC, **61**, 4, 567-574 (2014).
[3] F. Tricot et al., Proceedings of IFCS-EFTF (2017).