Progress in the evaluation of a Cs cell CPT clock using push-pull optical pumping

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We developed an experimental set-up to detect high-contrast CPT resonances in buffer-gas-filled Cs vapor cells using push-pull optical pumping (PPOP) [1]. The laser source of the system is a distributed-feedback (DFB) diode laser tuned on the Cs D_1 line at 894.6 nm. A Mach-Zehnder electro-optic modulator (MZ EOM) is driven by a 4.596 GHz local oscillator to generate two first-order optical sidebands frequency-separated by 9.192 GHz. The dc electrode bias voltage of the MZ EOM is actively controlled using an original microwave synchronous detector technique to stabilize optical carrier rejection (~28dB) at the output of the EOM. A Michelson-like interferometer allows to generate the so-called push-pull interaction scheme [2]. The laser light is transmitted through a Cs vapor cell filled with a buffer gas mixture of N2 and Ar. The laser power at the output of the cell is detected by a photodiode. The laser can be frequency stabilized onto the Cs-buffer gas cell into the bottom of the absorption line. The local oscillator frequency can be locked to the atomic 0-0 clock transition frequency.

In a first point, the impact of several experimental parameters (laser intensity, cell temperature, RF power, ..) on the clock resonance lineshape parameters is evaluated to find conditions that will optimize the clock short term frequency stability. First short term frequency stability results will be reported to evaluate the potential of this system.

In a second point, we will report a study on the impact of several experimental parameters on the clock resonance frequency. We will study the sensitivity of the clock resonance frequency to the EOM temperature, the EOM bias point, the EOM RF driving power, the static magnetic field, the optical path difference in the Michelson interferometer and laser intensity variations. Measurements of experimental parameters fluctuations will allow us to highlight critical key points to be improved to improve the clock frequency stability.

[1] Y. Y. Jau et al., Phys. Rev. Lett. 93, 160802 (2004).

[2] X. Liu et al., Phys. Rev. A 87, 013416 (2013)