# Exploring Ramsey-CPT spectroscopy in a microcell atomic clock

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Chip-scale atomic clocks (CSACs) based on coherent population trapping (CPT) have attracted significant research and development efforts due to their unrivaled size-power-stability budget [1]. In such clocks, the continuous-wave (CW) interaction of atoms with light yields power broadening and a significant sensitivity of the clock frequency to light-shift effects that contribute to the clock mid-term and long-term stability budget. Numerous approaches have been demonstrated in the literature to reduce light-shift effects in CW-CPT clocks [2-6].
In this study, using an external acousto-optic modulator to produce the interrogation sequence, we investigate the use of Ramsey-CPT spectroscopy in a buffer-gas filled microcell atomic clock. Some results are compared with those obtained in the standard CW regime.
In the Ramsey-CPT case, the clock frequency dependence to laser power is reduced by a factor of 60 with a dark time $T$ of 450 $\mu$s, at the expense of a 3 times higher operation power. The sensitivity to microwave power variations is reduced by a factor higher than 2. The Ramsey-CPT interrogation improves the clock Allan deviation for time scales in the 100 - $10^4$ s range, at the expense of a degraded short-term stability when the dark time $T$ is increased too much. A clock frequency stability of $3.8 \times 10^{-12}$ at $10^4$ s is obtained with $T = 450$ $\mu$s, in comparison with the level of $8 \times 10^{-11}$ obtained in the standard CW case, in similar experimental conditions and the same cell. These results suggest that Ramsey-based interrogation protocols might be an attractive approach for the development of CSACs with enhanced mid- and long-term stability.

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