Measurement of Buffer Gas Collisional Clock Frequency Shift in Cs Vapor Cells in Presence of He and Xe

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Introduction of buffer gas in vapor atomic cells is necessary to reduce the Doppler effect and to narrow the linewidth of the CPT resonance using the Dicke effect [1]. Femto-ST Institute developed an original technology for fabrication and filling of Cs vapor microcells with buffer gases [2]. The Cs vapor is generated after the complete sealing of the microcell by laser activation of a Cs dispenser developed by SAES Getters. Additionally, the cell is filled with a single Ne buffer gas permitting to cancel the temperature-dependence of the Cs clock frequency at a temperature inversion of about 80℃ [3]. This temperature is not enough for harsh environmental constraints applications and our Cs dispenser for- bids to use a N2-Ar buffer gas mixture, absorbing N2 buffer gas. We decided to investigate Cs clock frequency shift measurements in presence of other buffer gases, mainly Xe and He.

We implemented a laboratory-prototype Cs cell clock based on coherent population trapping. The laser source is a 1 MHz-linewidth distributed-feedback (DFB) diode laser turned on the Cs D1 line at 894.6 nm. The laser can be frequency stabilized onto Cs resonance by saturated absorption spectroscopy technique. A pigtailed phase electro-optic modulator (EOM), driven at 9.192 GHz, was used to generate 9.192 GHz frequency-splitted optical lines and to realize a CPT spectroscopy. We bought cm-scale commercially-available Cs cells filled with buffer gas (Xe and/or He). The cell was inserted in a physics package to be temperature-controlled and surrounded by a static magnetic field. The ensemble was inserted into a double-layer mu-metal magnetic shield.

First, we measured the actual buffer gas pressure in sealed cells through optical red shift measurements [4,5]. Then, once the buffer gas pressure was well known, we were able to determine the buffer gas collisional clock frequency shift coefficients by measuring the clock frequency shift as a function of cell temperature. The first estimations of these coefficients will be reported during the conference. Additionally, measurements of collisional frequency shift realized on microfabricated cells with new buffer gas mixtures will be reported.

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