Maser-like performance two-photon Rb optical frequency standard with a mm size vapor cell

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Rb 778 nm two-photon transition optical frequency standard (2hν-OFS) is an attractive vapor cell based optical frequency standard. Due to the Doppler-free spectrum and fluorescence detection method, 2hν-OFS can realize an extraordinary Signal-Noise-Ratio (SNR) and stability in a compact optical setup, and the reported best short-term and long-term stability are $1.8\times10^{-13}/\tau^{-1/2}$(<100 s) and 4×10^{-15} at 10000 s respectively[1,2]. With the significant progress of the chip-scale optical frequency comb technology, 2hν-OFS is being considered a promising transition scheme for miniaturized or chip-scale optical clock[3-5].

In the presentation, we demonstrated a maser-like performance 2hν-OFS employing a mm size vapor cell based on ^{87}Rb $5S_{1/2}(F=2)$-$5D_{5/2}(F'=4)$ transition. Fig. 1(a) is the measured typical Allan Deviation performance over a time record of 1000 s, showing a potential stability of $\sigma_y(\tau) = 4.5\times10^{-14}/\tau^{-1/2}$ (black dash), where the SNR shot-noise limit is about $4\times10^{-14}/\tau^{-1/2}$ and laser's phase noise limit (Intermodulation effect) is about $1\times10^{-14}/\tau^{-1/2}$. Fig. 1(b) is our cubic enriched ^{87}Rb vapor cell with a length of 7 mm. The cubic cell's walls are coated with 778 nm and 420 nm high-reflective films for the 778 nm probe beam counter-parallel configuration and a high fluorescence collection efficiency (~3%). More details about the experimental setup and further investigation on the long-term performance will be presented on the meeting.

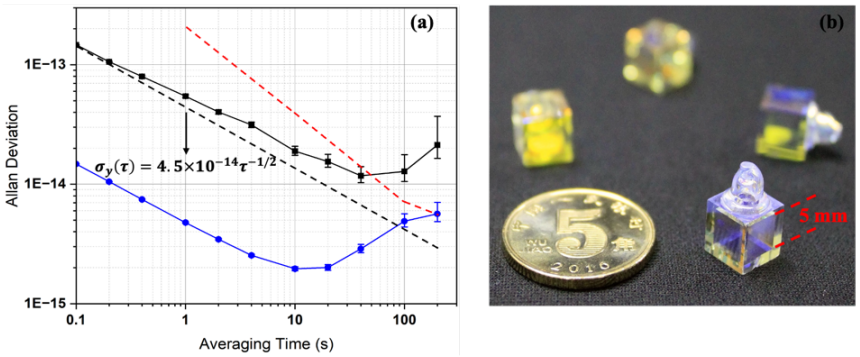

Fig. 1: (a) Measured short-term performance of 2hν-OFS (black square). Performance of the reference laser stabilized on an ultra-cavity (blue circle); Typical performance of H-maser (red dashed line); Potential stability (black dash). (b) Rb vapor cell.

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