A Novel Scheme for Coherent Population Trapping Atomic Clock Based on Linearly Polarized Light

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Abstract—CPT atomic clock is a compact atomic frequency standard based on coherent population trapping. The advantage of not requiring a microwave resonant cavity provides a possibility for miniaturization of a quantum device. Compared to circularly polarized light, linearly polarized light does not pump atoms into the dark state, thus improving the performance of CPT atomic clock. To generate CPT signals using linearly polarized light, the laser frequency needs to be locked at Fe=1 on the rubidium atomic D1 line[1]. Due to the broadening of spectral lines, it is difficult to distinguish between Fe=1 and Fe=2. The traditional method is to use an additional vapor cell to observe saturated absorption spectroscopy[2], but it increases the volume and power consumption of a quantum device. Here, we only use one vapor cell to simultaneously observe saturated absorption spectroscopy and CPT signals detected by differential detection. In the completed experiment, we observed saturated absorption spectroscopy and three CPT resonance peaks under weak magnetic fields. In the future, we will replace ECDL with VCSEL and achieve closed-loop locking of laser frequency and microwave frequency.

Keywords—CPT atomic clock, saturated absorption spectroscopy, differential detection, linearly polarized light

[1] Zibrov S A, Velichansky V L, Zibrov A S, et al. Experimental investigation of the dark pseudoresonance on the D 1 line of the 87 Rb atom excited by a linearly polarized field[J]. Journal of Experimental and Theoretical Physics Letters, 2005, 82: 477-481.

[2] Zibrov S A, Novikova I, Phillips D F, et al. Coherent-population-trapping resonances with linearly polarized light for all-optical miniature atomic clocks[J]. Physical Review A, 2010, 81(1): 013833.

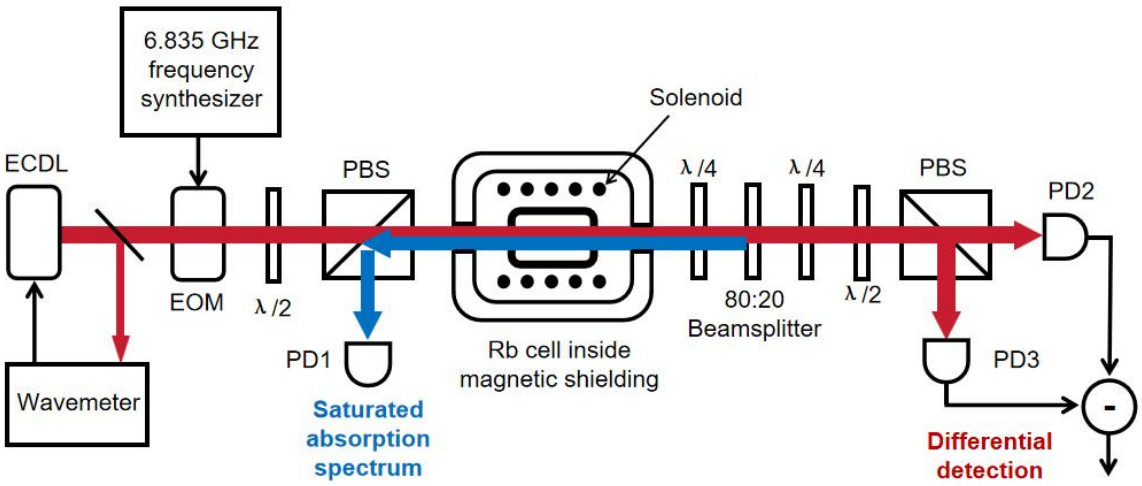

Fig. 1: Schematic of the experimental setup for saturated absorption and the differential detection of CPT signals

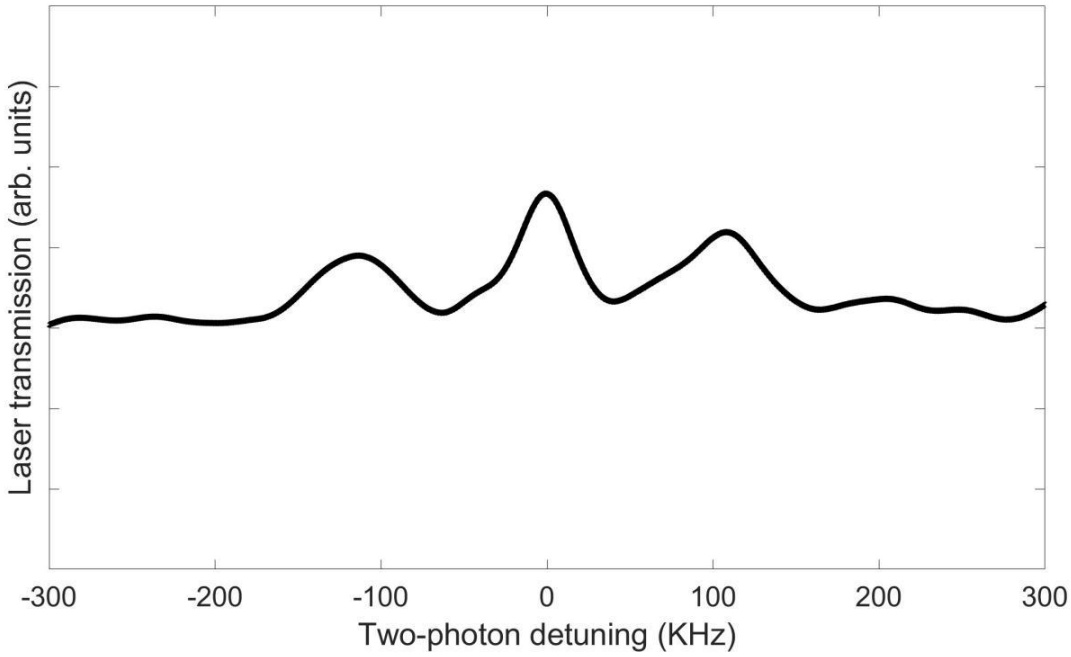

Fig. 2: Examples of measured CPT resonances at weak magnetic field

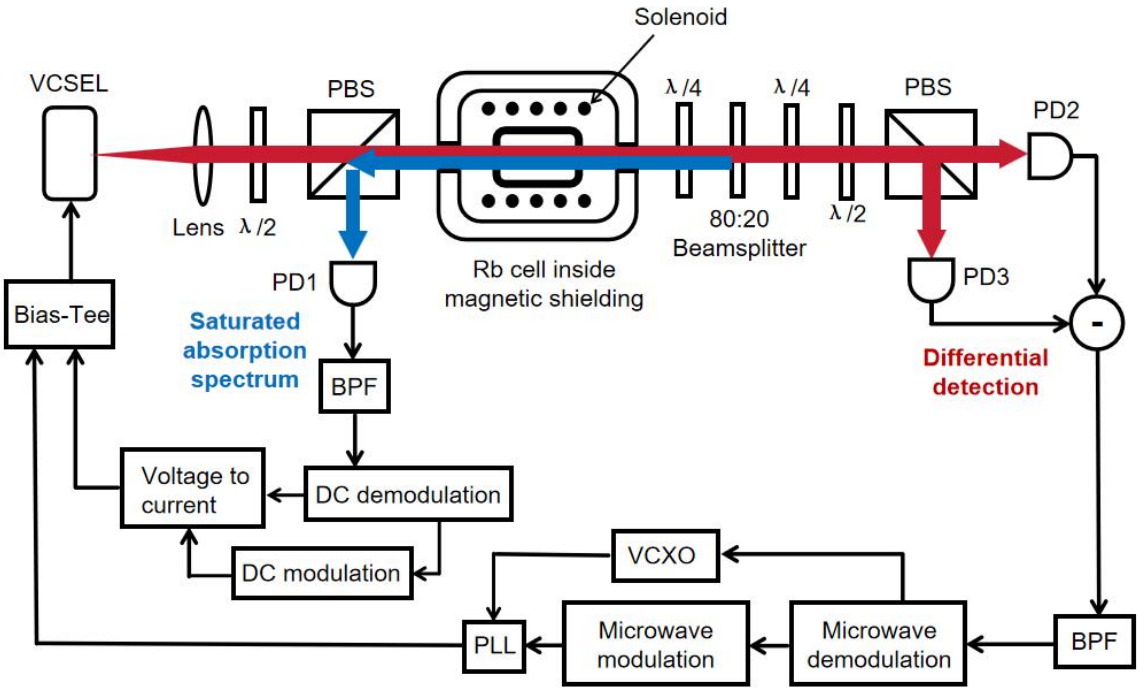

Fig. 3: Schematic diagram of the system to be implemented later