Exploring a new scheme for Ramsey-CPT atomic clock

Jing Yang[1], Yuan Tian[2], Bozhong Tan[2], Peter Yun[1], Sihong Gu[1, 2]

[1] Key Laboratory of Atomic Frequency Standards, Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences, Wuhan, People's Republic of China
[2] Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology, Wuhan, People's Republic of China

Email: shgu@wipm.ac.cn

The narrow linewidth Ramsey Coherent Population Trapping (CPT) interference fringe obtained from phase interference between separately generated CPT resonances can be used to implement atomic clock, and a short term frequency stability of $10^{-13}\tau^{-1/2}$ has been achieved with a Ramsey-CPT atomic clock [1, 2]. However, in prevalent Ramsey-CPT atomic clock schemes atoms interact with the pulsed laser and an acousto-optic modulator (AOM) is used to generate the pulsed laser[1-3], and the AOM prevents the clock from a compact one. We propose a frequency switching Ramsey-CPT atomic clock scheme. In the scheme a vertical cavity surface emitting laser (VCSEL) drove by periodically microwave modulated current is employed to provide laser for interacting with atoms, and the VCSEL's output switches between monochromatic and multichromatic laser. When the multichromatic laser illuminating atomic vapor cell its two frequency components interact with atoms to generate CPT resonance and when the monochromatic laser illuminating the cell there is no interaction due to off resonance between laser and the atoms. Therefore Ramsey-CPT interference can be realized by twice resonances between multichromatic laser and the atoms. We have experimentally studied the scheme and compared with the prevalent one, our experimental results suggest that the frequency stability of the proposed Ramsey-CPT atomic clock could be competitive with that of the prevalent schemes. With eliminating AOM, the physics package is basically the same as that of the conventional CPT atomic clock, while the resource budget of the electronics will also be close although a microwave switch will be added. Therefore, it is promising to realize a competitive compact Ramsey-CPT atomic clock through the proposed scheme.

---

[1] R. Boudot, S. Guerandel, E. de Clercq, N. Dimarcq, and A. Clairon, "Current Status of a Pulsed CPT Cs Cell Clock", IEEE Trans. Instrum. Meas., vol. 58, p. 1217-1222, 2009.

[2] N. Castagna, R. Boudot, S. Guerandel, E. de Clercq, N. Dimarcq, and A. Clairon, "Investigations on Continuous and Pulsed Interrogation for a CPT Atomic Clock", IEEE Trans. Ultrason., Ferroelect., Freq. Contr., vol. 56, p. 246-253, 2009.

[3] Y. Peter, Z. Yi, L. Guobin, D. Wei, Y. Li, and G. Sihong, "Multipulse Ramsey-CPT interference fringes for the ^{87}Rb clock transition", Europhys. Lett., vol. 97, p. 1-5, 2012.