# 연속 저속 원자빔을 이용한 세슘 주파수 표준기

# Cesium Frequency Standard Based on a Continuous Slow Atomic Beam

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Laser-cooled slow atoms can lead to a considerable improvement in both the accuracy and the frequency stability of atomic frequency standards. Most of the developed frequency standards with the slow atoms use atomic fountain scheme that includes pulsed atomic beam. Although this type of frequency standard has already demonstrated the accuracy about $10^{15}$ level[1], a continuous beam of slow atoms may become an alternative approach, because the pulsed operation of the atomic fountain has some drawbacks such as the collisional shift and the limitation in the short-term frequency stability.

We produced a continuous beam of slow atoms from a thermal cesium atomic beam by illuminating a red-detuned broad-band laser light to the thermal atomic beam. The decelerated atoms were deflected at an angle of 30 degree by optical molasses, and entered a vacuum chamber to be used as an atomic beam source for a frequency standard. We obtained a 62 Hz wide Ramsey fringe from a 21 cm long Ramsey cavity by using the continuous slow atomic beam. This linewidth is about four times narrower than that of KRISS-1 with a 37 cm long cavity and a thermal beam[2].

The experimental setup consists of two basic parts. One part includes a vacuum tube for generation a slow atomic beam, the other one includes a vacuum chamber for a microwave interrogation of the atomic beam (Fig.1). The Rabi-Ramsey spectrum was observed as the microwave frequency was swept around the clock transition frequency. The magnetic field of about 0.8 $\mu$T was applied to the drift region. Fig. 2 shows the result when the laser was frequency-stabilized at three different resonance lines: F=4→F'=4, F=4→F'=3, and at the crossover resonance between these transitions. A Ramsey fringe was observed and compared with the theoretical one (Fig. 3), which was calculated assuming that the mean velocity was 30 m/s and the rms velocity was 2 m/s. Both the fringes have a similar pattern but a different magnitude. The small magnitude of the experimental fringe might be due to the scattering or collision of atoms during passage between two interaction arms of the Ramsey cavity. The atoms were so slow that scattering or collision with other particles in the vacuum chamber might occur and accordingly the atomic state might change. Therefore, higher vacuum was required to reduce the scattering rate and consequently to get a large magnitude. Anyway, this narrow Ramsey fringe has a potential to improve the performance of the atomic beam frequency standard.

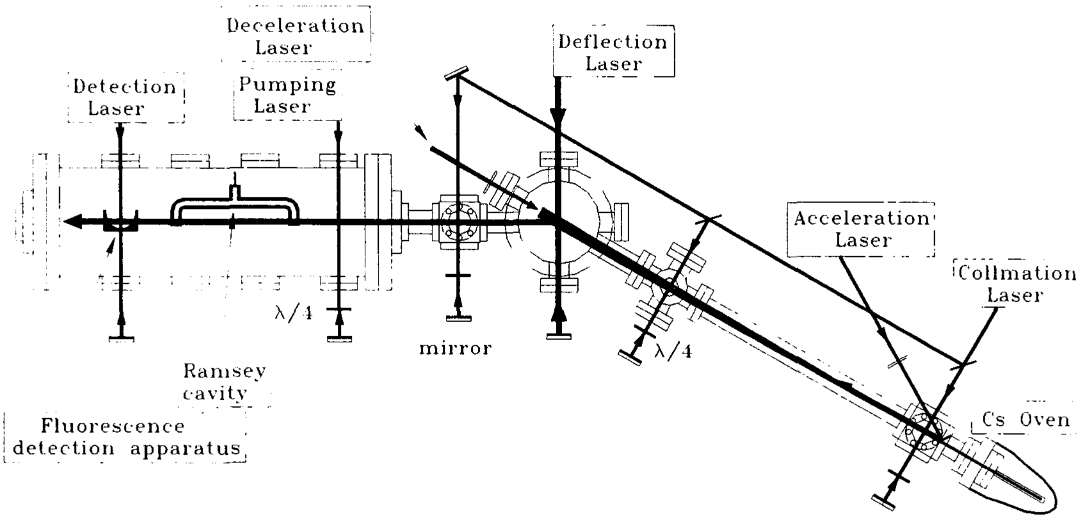


Fig. 1. Schematic diagram of the experimental setup.

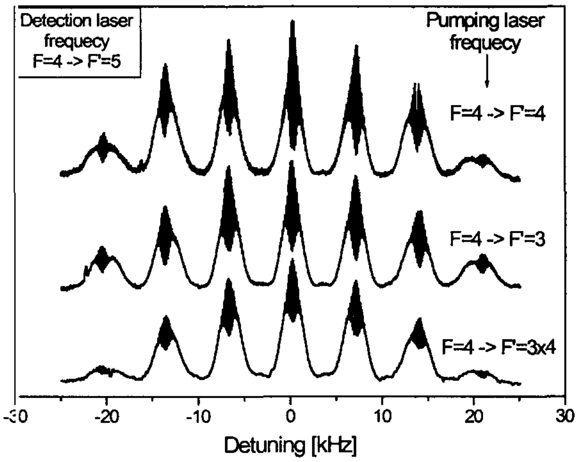


Fig. 2. Rabi-Ramsey spectrum obtained with the sow atomic beam.

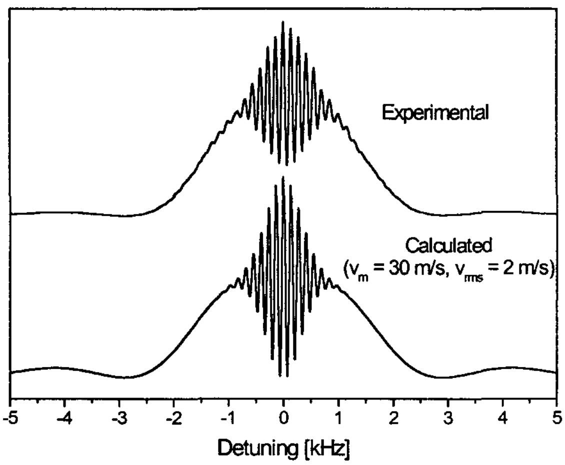


Fig. 3. Ramsey fringe on the Rabi pedestal (a) measured and (b) calculated.

References

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