Preliminary Results of a Portable Cold ^{87}Rb Atomic Clock in NIM

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Abstract

A portable cold ^{87}Rb atomic clock is under development in NIM. The ^{87}Rb atoms are trapped and cooled in a small three-dimensional magneto-optical trap (3D MOT) chamber. Then, they are released and prepared to the $|F=2, m_F=0\rangle$ clock state by $|2\rangle \rightarrow |2'\rangle$ optical pumping (OP) directly during the free-falling. After that, the free-falling atoms enter a microwave cavity where they undergo microwave interrogation. Eventually, the atomic numbers on the $|2\rangle$ and $|1\rangle$ states are detected with the vertical cooling beams by one photo-diode detector in the detection chamber.The preliminary results show that, the atom number has been increased about 3 times by the optical pumping compared to the microwave state selection method. And a Ramsey fringe has been obtained experimentally, and the contrast of the central Ramsey fringe exceeds 88% with a full width half maximum (FWHM) of less than 9 Hz.

Motivation

Atomic frequency standards are used to generate accurate and precise time and frequency, having made considerable contributions to the fields such as communications, synchronization, financial transactions and navigation systems in modern life [1, 2]. Many applications ask for an atomic frequency standard to be robust and having the features of compact size, low weight and low power consumption. Also, it is expected with accuracy and short- and long-term stability comparable to the best current primary standard. Thus, compact cold atoms clocks have attracted extensive attention in the past two decades, and some are already commercial available [3-5]. In our lab, we attempt to develop a portable free-falling-typed cold-atom microwave clock.

Results

The changes of atom number in $F=2$ state when sweeping the frequency of interrogation microwave with and without optical pumping selection, are show in Fig.1. It shows that the selected atom number has been increased about 3 times by the optical state selection compared to that by the microwave state selection method. With optical pumping selection, a Ramsey fringe has been obtained experimentally and is shown in Fig. 2. And it shows that the contrast of the central Ramsey fringe exceeds 88% with a full width half maximum (FWHM) of less than 9 Hz.

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Figures

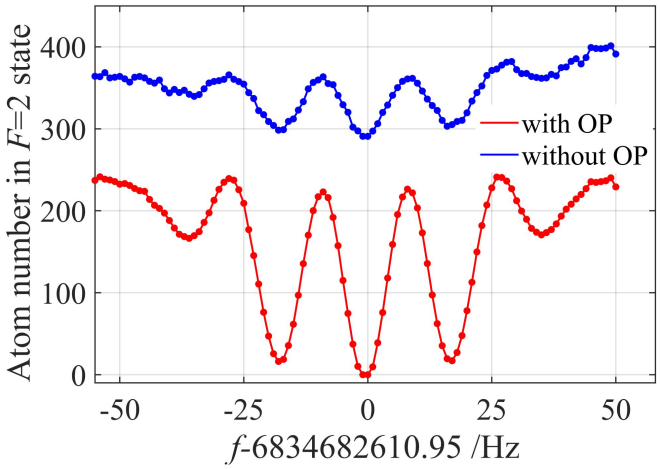

Fig.1. Change of atom number in F=2 state when sweeping the frequency of interrogation microwave with and without optical state selection

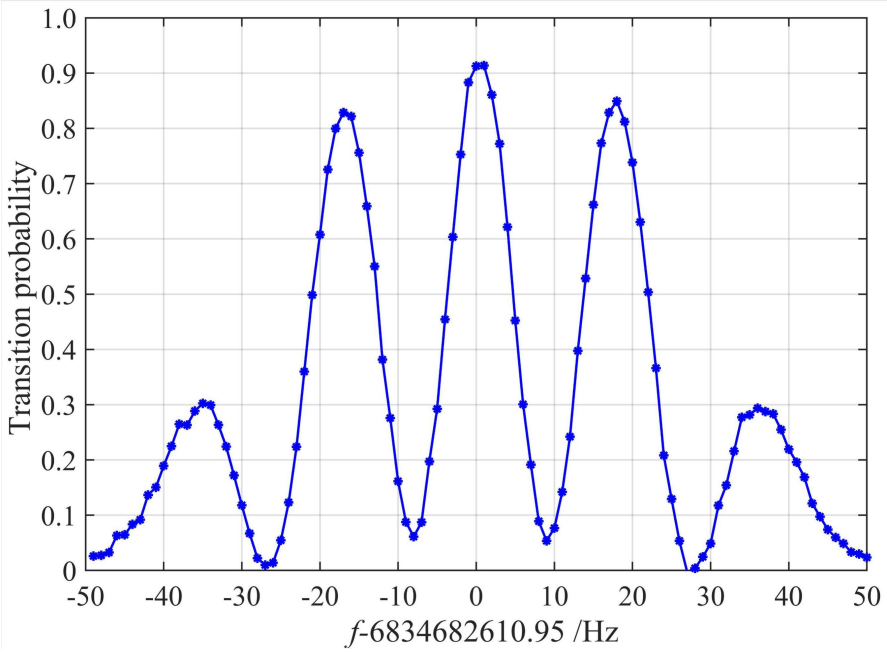

Fig. 2. Ramsey fringe of the $|2, 0\rangle \leftrightarrow |1, 0\rangle$ clock transition. The central fringe has a FWHM width of less than 9 Hz and a contrast of 88%.