High-Contrast Sub-Doppler Resonance Observed in a Cesium Vapor Cell for Applications in the Compact All-Optical Atomic Clocks

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Coherent population trapping phenomenon (CPT) underlies the high-performance compact and miniature atomic clocks [1,2]. The dark resonance caused by CPT in atomic vapor serves as a reference for stabilization of a microwave oscillator frequency used in these devices. One of the main problems limiting the frequency stability of the oscillator is connected with the light shift of the resonance. Time deviation of this shift can be resulted from the deviations of laser radiation parameters: optical frequency, total power of a beam or relative power of frequency components.

The latest versions of the clocks [3,4] set in use new spectroscopic technique to stabilize the laser optical frequency, leading to unprecedented level of the microwave frequency stability ($\sigma_y \sim 10^{-13}\tau^{-1/2}$). The technique is based on the new nonlinear effect, which has been recently observed in a vacuum cesium vapor cell [5]. The effect consists in creation of a natural-linewidth resonance in the cell during the laser carrier frequency scanning under the two-frequency regime. The bright feature of the resonance consists in its really high contrast under the certain physical conditions. In spite of the new effect is becoming very useful tool for optical frequency stabilization in CPT clocks, the effect has not been studied. Our current study is aimed to eliminate this lack of knowledge (see also [6]).

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