Electromagnetically induced transparency in a non-degenerate four-level N-type scheme in ^{87}Rb

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The results of the first experimental observation of electromagnetically induced transparency (EIT) in a *nondegenerate* four-level N-type scheme are presented [1]. Earlier the *degenerate* schemes were studied experimentally by Akulshin *et. al.* [2] and theoretically by Taichenachev *et. al.*[3].

Our experiments were performed on the D_2 absorption line of ^{87}Rb. An experimental setup was based on two independent external cavity diode lasers ECDL [Fig.1(a)] . The copropagating orthogonally polarized laser beams were passed through a rubidium cell. The frequency of one of the lasers (laser 1) was fixed and tuned on the center of the Doppler broadened group of transitions $5S_{1/2}$(F=2)→ $5P_{3/2}$(F=1, 2, 3) [Fig.1(b)]. The absorption of emission of the laser 1 was measured. The frequency of the second laser (laser 2) was scanned across the Doppler broadened transitions $5S_{1/2}$(F=1)→$5P_{3/2}$(F=0, 1, 2). In this conditions we observed a conventional single EIT resonance [Fig.2(a)] in the two photon Raman-type schemes $5S_{1/2}$(F=1)↔$5P_{3/2}$(F=1)↔ $5S_{1/2}$(F=2) and $5S_{1/2}$(F=1)↔ $5P_{3/2}$(F=2)↔$5S_{1/2}$(F=2) for two velocity groups of atoms.

Then rf modulation at the frequency f near 156.9 MHz (the frequency corresponded to the

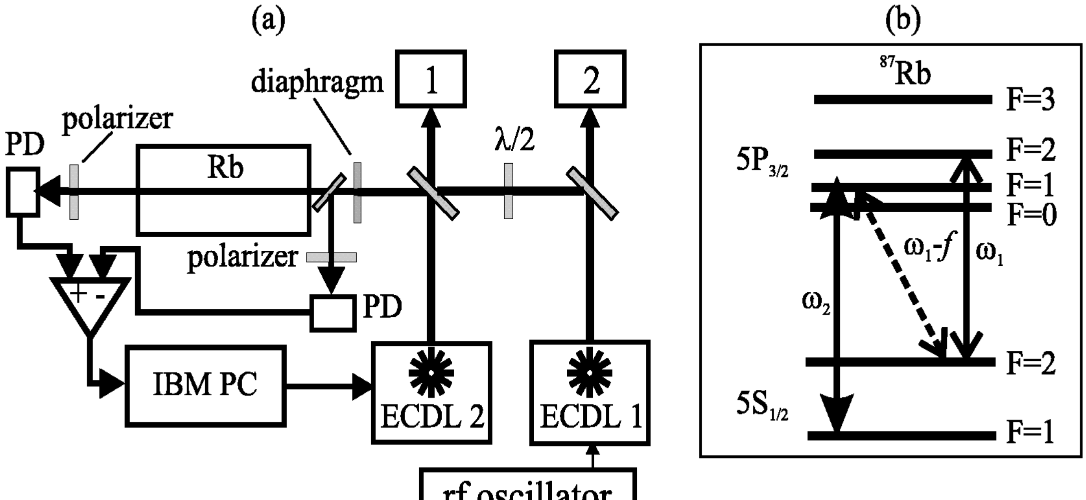

Figure 1: (a) Scheme of the experiment. 1 and 2 are the saturated absorption setups. (b) Scheme of the transitions in ^{87}Rb.

splitting of F=1, 2 hyperfine sublevels of the $5P_{3/2}$ excited state) was fed to the laser 1 injection current. Therefore three frequencies appeared in the laser spectrum. In these conditions a strong interaction of atoms with the three laser fields ω_1, ω_2 and ω_1+f or ω_1-f was established [Fig.1(b)]. At certain frequencies of the laser 2 the N-type three-photon interaction arose in the circuits $5S_{1/2}$(F=1)↔ $5P_{3/2}$(F=1)↔ $5S_{1/2}$(F=2)↔ $5P_{3/2}$(F=2) or $5S_{1/2}$(F=1)↔ $5P_{3/2}$(F=2)↔ $5S_{1/2}$(F=2)↔ $5P_{3/2}$(F=1).

As a result we have observed two additional EIT resonances detuned by $\pm f$ from the main EIT dip in the absorption of laser 1 [Fig.2(b)]. In fact, the presented phenomenon corresponds to the translations of the frequency of the EIT resonance. The width of the three-photon interference peaks in our experiments was determined by the lasers frequency noise (~2MHz). The behavior of the resonances in weak magnetic field has been investigated.

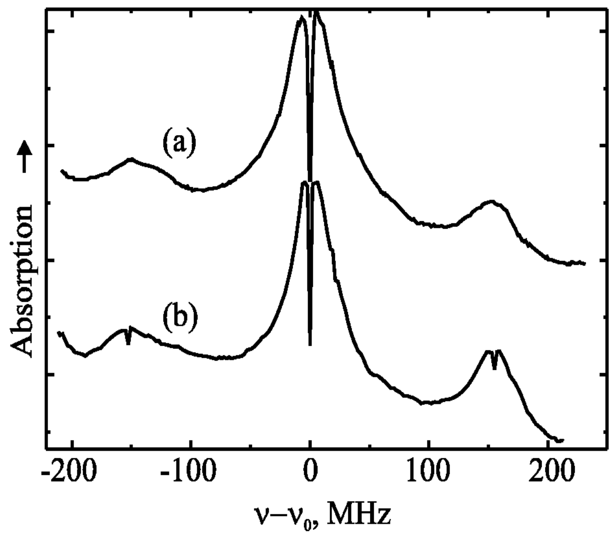

Figure 2: Absorption spectrum of the laser 1 with a fixed frequency under scanning the frequency of the laser 2. The ν_0 is the position of the ordinary exact Raman resonance. (a) Absorption without rf modulation of the laser 1. (b) Absorption in the presence of rf modulation at the frequency 156.9 MHz.

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