Treating cesium resonance lines with femtosecond pulse train

N. Vujicic, S. Vdovic, T. Ban, D. Aumiler, H. Skenderovic and G. Pichler
Institute of physics, Bijenika 46, Zagreb, Croatia
E-mail:pichler@ifs.hr

We present results of recent experiments when cesium vapor were illuminated by the femtosecond laser frequency comb centered at either D2 line at 852 nm or D1 line at 894 nm. This action changed the usual Doppler profile into very peculiar profile in which periodic structure can be observed by cw laser scanning probe. The periodic structure reflected the frequency spectrum of the pulse train consisting of a series of fringes separated by the pulse repetition rate. In cesium system the atomic coherence relaxation time is longer than the laser pulse repetition period. Cs atoms interact with the spectrum of the pulse train, and not with the spectrum of a single pulse. This open up a possibility for the high resolution spectroscopy [1,2], where the observed linewidths are much less than the Fourier- transform limit of the individual pulse in the train.

In our recent papers [3,4] we presented the observation of the velocity selective population transfer between the Rb ground state hyperfine levels induced by fs pulse train excitation. We developed a modified direct frequency comb spectroscopy (DFCS) which uses a fixed frequency comb for the ^{85,87}Rb $5^2S_{1/2} \rightarrow 5^2P_{1/2,3/2}$ excitation (Tsunami mode-locked Ti:sapphire laser with pulse duration of 100 fs and pulse repetition of 80 MHz) and a weak cw scanning probe (TOPTICA DL100, ECDL at 780 nm) for ground levels population monitoring. The Rb($5^2P_{1/2,3/2}$) excited atomic levels have the relaxation times greater than the fs laser repetition period.

We shall present velocity selective optical pumping of the ground hyperfine levels in cesium atoms achieved by femtosecond laser oscillator. Modulations in the hyperfine absorption line profiles are observed as a direct consequence of the velocity selective optical pumping induced by the frequency comb excitation. In addition, we show the results of the use of a hyperfine Cs filter, which selectively absorbs frequency comb lines over the Doppler profile.

References

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