Coherent effects in mismatched V-type rubidium system

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Mismatched V-type systems with coupling field frequency lower than the probe field frequency are ideal candidates for the high-frequency inversionless laser systems [1]. On that account, the study of electromagnetically induced transparency (EIT) in such systems represents the first step in the realization of a high-frequency inversionless lasers [2, 3]. EIT creates the reduction in absorption upon which the LWI is based. Additionally, the V-type configuration provide potentially the best level of transparency in a Doppler-broadened systems, particularly for the cases in which the probe frequency is far in excess of the coupling field frequency [4, 5].

Induced transparency on a blue 420 nm probe light in a Doppler broadened mismatched V-type system using a low power near infrared (780 nm) coupling laser was experimentally observed. Theoretical modeling was carried out utilizing standard density matrix analysis of three-level V scheme with appropriate modifications to take into account the hyperfine splittings of the 5 $^2S_{1/2}$ ground and 5 $^2P_{3/2}$, 6 $^2P_{3/2}$ excited states. Calculated probe absorption line profiles reproduce with great accuracy measured absorption profiles.

Measured transparency on the ^{85}Rb F_g=2 F_e=1,2,3 transitions shows 67% reduction of absorption in the peak of the Doppler broadened line profile. The dependence of the induced EIT window in the ^{85}Rb F_g=2 F_e=1,2,3 absorption line profile on 5 $^2P_{3/2} \rightarrow 6^2P_{3/2}$ unlinked states coherence was analyzed theoretically. In this way it was possible to separate two main mechanisms responsible for the reduction of the absorption in the V-type system: electromagnetically induced transparency and coupling field saturation. We conclude that the observed transparency is predominantly resulting from the coupling field saturation mechanism. There is about 8% of the cancellation of absorption via quantum interference due to coherently prepared rubidium atoms.

References

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