DEGENERATE AND NON-DEGENERATE FOUR-WAVE MIXING IN COLD CESIUM ATOMS WITH OPTICAL PUMPING

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Resonant four-wave mixing (FWM) is a powerful nonlinear spectroscopic technique which has been widely employed to investigate a variety of nonlinear optical media. In a low-density Doppler-broadened vapor, FWM can be used to observe sub-Doppler resonances as well as to study saturation effects associated with the third order nonlinear susceptibility $\chi^{(3)}$ of the medium. With the phenomenal development achieved in the field of laser cooling and trapping of neutral atoms, samples of atoms with high densities and very low temperatures can now be easily obtained. These samples of cold atoms offer the possibility to perform FWM in a completely new domain. Differently from a room temperature atomic vapor, where just a small velocity group within the sample contributes to the FWM signal, with cold atoms this contribution comes from all the atoms. In this work we present a detailed investigation on the generation of four-wave mixing optical phase conjugation using a noncycling transition of cold cesium atoms obtained from a four-beam magneto-optical trap [1,2]. In particular, we study the efficiency of the four-wave mixing signal as a function of the density of trapped atoms as well as the intensity of the trapping beams. A simple theoretical model which accounts explicitly for the relaxations between the two hyperfine cesium ground states in the trap environment is in qualitative agreement with some of the observed results. We will also present the observation of nondegenerate four-wave mixing with hyperfine levels population transfer induced by optical pumping. Application of this effect to measure atomic diffusion in the trap will be discussed.
[1] J.W.R. Tabosa, S.S. Vianna, and F.A.M. de Oliveira, to appear in Phys. Rev. A (1997). [2] J.W.R. Tabosa and S.S. Vianna, submitted to Braz. J. of Phys. (1996).
