Parametric dispersion in electromagnetically induced transparencies

M. Müller[1], R.-H. Rinkleff[1], and K. Danzmann[1,2]

[1] *Institut für Atom- und Molekülphysik, Abt. Spektroskopie, Universität Hannover*
Callinstr. 38, D-30167, Hannover, Germany
Tel +49-511-762 3437, Fax +49-511-762 2784
E-mail: mgm@mpq.mpg.de, Website: http://www.amps.uni-hannover.de
[1,2] *Max Planck Institut für Quantenoptik, Aussenstelle Hannover*

Quantum coherence effects in atomic media interacting with multiple coherent electromagnetic fields have gained a lot of theoretical and experimental interest in the field of quantum optics over the last years [1]. The absorptive and dispersive properties of coherently prepared media lead to astonishing effects like electromagnetically induced transparencies on extremely narrow dark resonances [2].

We report on the investigation of the parametric phase shift of a fixed coupling laser field in a nonabsorbing medium. The parameter under variation is the frequency of a probing laser field acting on the second transition in a Λ-type three level system. In this system with one laser field coupling the upper level to one of the two ground states exactly on resonance and the other laser field probing the second optical transition, both fields undergo depending on their Rabi frequencies a very rapidly varying phase shift with a simultaneously vanishing absorption. While the probe field dispersion spectrum consists of the normal refractive index profile and a very narrow inverted structure at the two photon resonance, the coupling field dispersion only shows the central structure resulting from the two photon interaction. This parametric dispersion of the coupling field depends on the Rabi frequencies of the involved fields and the relaxation time of the ground state coherence.

The system we used was a three level system in the D_2-line of cesium. The phase shift was measured with a three beam heterodyne interferometer relative to an offresonant reference laser field. This setup is less sensitive ti acoustic and vibrational noise tha a homodyne interferometer of Mach-Zehnder type and provides reasonable signal-to-noise ratio even at coupling powers of a few nW. The power of both coupling and probe laser field was varied over several orders of magnitudes and the obtained phase shifts are in good agreement with the semiclassical model.

Acknowledgments. This work was supported by SFB 407 of the Deutsche Forschungsgemeinschaft.

[1] E. Arimondo, *Progress in Optics* **35** (Elsevier, Amsterdam, 1996) 257-354.
[2] G. Müller, A. Wicht, R.-H. Rinkleff, K. Danzmann, *Optics Commun.* **127** 37 (1996).