Electromagnetically induced transparency of a negative dispersive medium

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The basic feature of electromagnetically induced transparency is a strong reduction of the light absorption by an atomic medium at a resonance frequency. Electromagnetically induced transparency of a negative dispersive medium can be generated e.g. in a strong driven two level atom, as it is shown teoretically [1]. When this medium is placed inside an optical resonator, it increases its bandwidth without sacryfing its build up (white light cavity). This could be a promising application for gravitational wave detectors, to enhance both the signal and their bandwidth [2].

We present an experimental setup [3] which is used to realize a negative dispersive non absorbing medium and to investigate its optical properties. A two level atom strongly driven at the resonance was chosen to investigate the absorption and the index of refraction. For the simultaneous high precision measurement of lost and phaseshift imposed on a probe field during the interaction with a chopped atomic beam we used a novel spectrometer, which is based on a Mach Zehnder interferometer with a phase modulated reference arm. The combination of interferometry and FM-Spectroscopy takes advantage of both methods, therefore the phase shift measurement is in principle, shot noise limited.

The calcium transition $4s^2\ ^1S_0 \rightarrow 4s4p\ ^1P_1$ at 423nm was used to realize the strongly driven two-level atom. First experimental results on the realization of negative transparent media are reported. From the measurement performed at different Rabi-frequencies we have determined the absorption and dispersion at resonance: On the strongly driven atoms we measured a dispersion of $\partial_\omega n_0 = -(3.1 \pm 1.0) \times 10^{-10}/\mathrm{MHz}$ accompanied by a residual absorption of $\alpha_0 = 0.125 \pm 0.040\%/cm$. It was reached a regime of driving intensity, where the suppression of absorption overcomes the suppression of dispersion. Therefore we have in principle demonstrated experimentally, that negative dispersive transparent media can be realized.

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