Giant polarization rotation induced by THz ultrashort pulses

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Ultrashort single cycle THz pulses are found to induce a giant polarization rotation for visible light in $LiNbO_3$ crystal. Under specific conditions, the THz propagation through the $LiNbO_3$ crystal leads to efficient modulation of the polarization state of femtosecond optical probe pulses in time-resolved experiments. This time-dependent electro-optical polarization modulation is governed by $\chi^{(2)}$-type interactions between optical and THz electromagnetic pulses and occurs in the bulk of the crystal. In our experiments we use a Ti:Sa laser to generate intense THz pulses by means of the tilted-front pulse method in a MgO-doped $LiNbO_3$ crystal [1]. The emitted THz pulses are collected and focused into the sample (1 mm thick Z-cut undoped $LiNbO_3$). The THz pump pulse and a time-delayed femtosecond probe pulse interact together inside the sample and the probe's polarization rotation is followed in time with a polarization sensitive detection scheme as shown in Fig. 1.a). Fig. 1.b) shows a typical signal obtained at a probe incidence internal angle of 9°, with different modulation frequencies appearing. Fig. 1.c) shows that, for different angles between THz and probe, different frequencies of modulation can be obtained up to roughly 1.6 THz. The experimentally measured maximum angle of polarization rotation of 6° is large compared to other studies [2], and represents a new pathway for controlling the polarization state of light at ultrafast time scales.

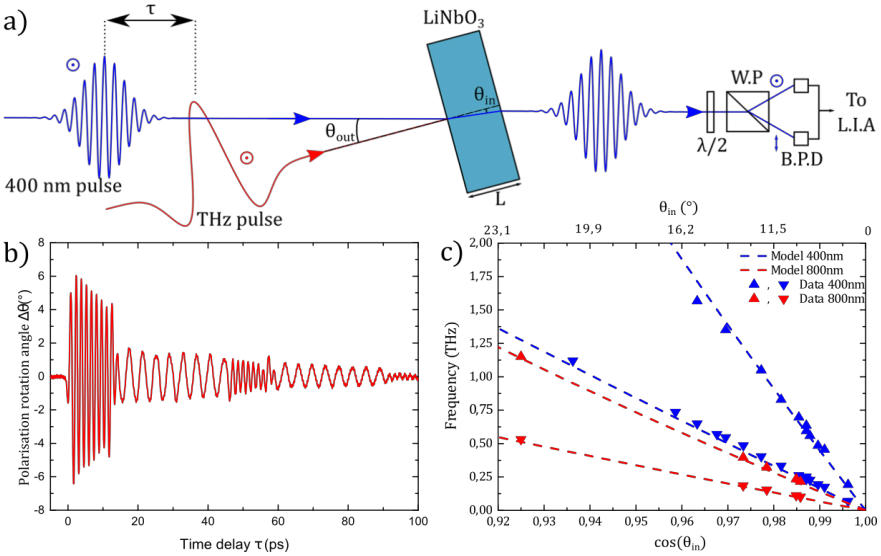

Fig.1. a) Schematic of the time-resolved Kerr rotation measurement in $LiNbO_3$. b) Intensity modulation resulting from probe's polarization rotation as a function of the time delay between the THz pump pulse and the 400 nm probe pulse. c) The measured two frequencies as a function of the intern angle θ_{in}. The dashed lines are results of model calculations.

References

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