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Electric control of the unidirectional transmission in the ferrotoroidic LiCoPO4

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Multiferroics allow the magnetic control of electric polarization and the electric control of magnetization via the static magnetoelectric effect (ME). Dynamic or optical ME effects gained high interest because they give rise to unidirectional transmission - as recently observed in low-temperature multiferroics. This phenomenon allows the development of optical diodes, which transmit unpolarized light in one, but not in the opposite direction. Ferroelectric polarization and spontaneous magnetization in multiferroics can be exploited to switch the transmission direction with either magnetic or electric field as shown in Fig. 1. In prior optical directional effects in solids were only investigated with magnetic field, but were never tested in the presence of external electric field before.
LiCoPO4 is a well known multiferroic material with an exotic, recently discovered degree of freedom known as torroidal moment [4]. Neutron diffraction and magnetization studies have revealed complex magnetic phases in both compounds pointing to the existence of several competing energy scales. The exotic magnetic interactions and the possible finite macroscopic torroidal moment of this material promote it to an ideal candidate for novel optical magnetoelectric experiments.
By means of far-infrared absorption measurements we have revealed the existence of unidirectional transmission which could be controlled by either magnetic or electric fields (Fig.1). The samples were cooled down to the antiferromagnetically ordered phase in crossed electric and magnetic fields and the measurements were performed in the presence of these static fields.

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