Directional Dichroism of THZ Radiation in the Canted AFM Phase of $BiFeO_3$

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Introduction

Multiferroics (MF) permit the magnetic control of the electric polarization and the electric control of the magnetization. These static magnetoelectric (ME) effects are of enormous interest: The ability to read and write a magnetic state current-free by an electric voltage would provide a huge technological advantage. Optical ME effects are equally interesting, because they give rise to unidirectional light propagation as recently observed in low-temperature multiferroics[1]. $BiFeO_3$ is the only room temperature MF and has the largest spin-driven polarization among MF. The material shows directional dichroism (DD) at THz frequencies even at room temperature and it is established that the optical ME effect is caused by the spin-current mechanism in the cycloidally ordered magnetic phase[2].
In the magnetic fields above 18T the spin cycloid is destroyed, accompanied by a sudden change of the electric polarization along the hexagonal axis parallel to the existing FE polarization. It has been found recently that the linear ME effect exists in the canted AFM phase[3]. To unravel the mechanism of linear ME coupling in the canted AFM phase we have undertaken a study of DD above 18T in the THz range.

Experimental

Experiment was carried out in cell 8 on the 35T 32mm bore magnet at 5K using quasi-optical cryostat. THz radiation was generated with backward wave oscillators and detected with the hot electron bolometer operating at T=4K. Radiation was propagating perpendicular to the magnetic field (Voigt configuration).

Results and Discussion

We studied the polarization dependence of the higher AFM mode (AFM2) for magnetic field in three principal hexagonal directions, B||[111], B||[1-10] and B||[-1-12], given in pseudo-cubic notation. The result for B||[1-10] is shown in Fig.1. The AFM2 mode shows DD as shown in Fig.2.

Conclusions

We detected DD and determined the selection rules for the AFM2 mode. The experimental part of this study is now completed.

Acknowledgements

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References

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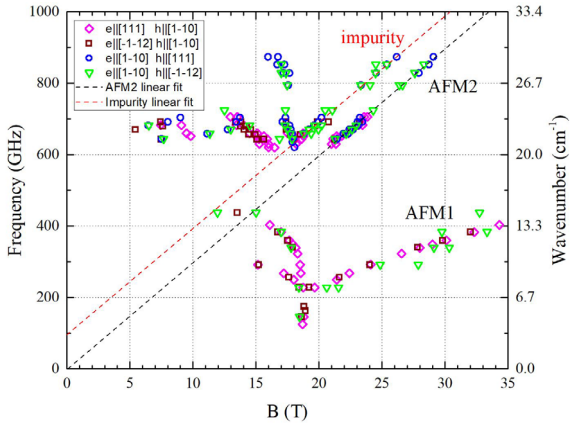

Fig. 1: Frequency vs field plot for the B||[1-10] direction.

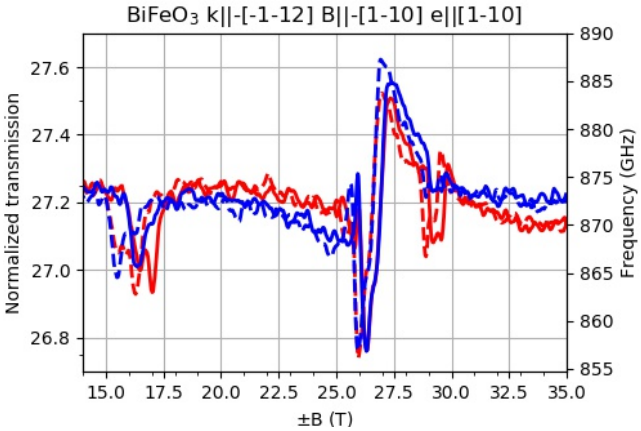

Fig. 2: AFM2 spectra showing DD at 874GHz. Red is positive (+B) and blue is negative (-B) field direction.