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Optical Magnetoelectric Effects in Multiferroics¹

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Multiferroics show peculiar magneto-optical properties: Optical refractive index and absorption change with the reversal of the propagation vector \mathbf{k} of the electromagnetic wave. This magneto-optic effect is clearly distinct from the conventional magneto-optics like Faraday effect and named optical magneto-electric effect, because it can be considered as the high-frequency extension of the linear magneto-electric effect in multiferroics. We have recently succeeded in detecting the optical/x-ray magneto-electric effect in a polar ferrimagnet GaFeO_3 , where spontaneous polarization \mathbf{P}_0 and magnetization \mathbf{M}_0 are parallel to the b and c axes, respectively. Optical magneto-electric effects are expected to show up for the electromagnetic wave with \mathbf{k}/a , as the difference in absorption and refractive index with the sign reversal of the triple product of \mathbf{P}_0 , \mathbf{M}_0 , and \mathbf{k} . X-ray magneto-electric absorption shows large enhancement at Fe $1s$ - $3d$ transition.¹ The obtained spectra are well explained by the interference between electric dipole and electric quadrupole transitions of Fe $1s$ electrons in an FeO_6 cluster. Optical magneto-electric absorption of the order of 10^{-3} was observed at around Fe intra-atomic d-d transition.² *Measurements of x-ray spectroscopy were performed at BL-1A, KEK-PF, Japan. ¹M. Kubota et al., Phys. Rev. Lett. **92** (2004) 137401. ²J. H. Jung et al., Phys. Rev. Lett. **93** (2004) 037403.

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