X-ray Magnetic Circular Dichroism in a Chiral Antiferromagnet

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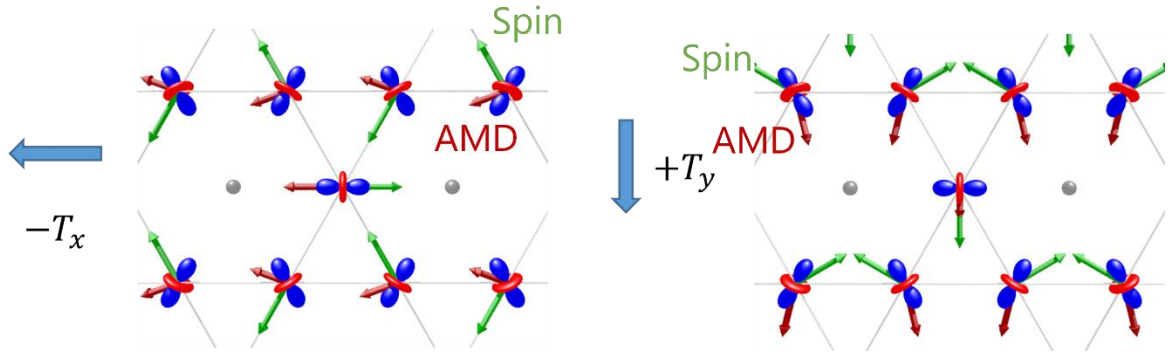
X-ray magnetic circular dichroism (XMCD) has become a versatile technique to ferro- and ferrimagnetic magnetic materials. The technique enables us to extract the expectation values of the element-specific spin and orbital moments. In contrast, it has been generally believed that XMCD does not occur in antiferromagnets which do not have net magnetization.

A chiral magnet Mn_3Sn exhibits a coplanar 120° antiferromagnetic (AFM) order on breathing Kagomé-type Mn network, which breaks the time reversal symmetry and allows the anomalous Hall effect [1] and the magneto-optical Kerr effect (MOKE) [2] even though the magnetic moments almost cancel each other. We have theoretically investigated a possibility of x-ray magnetic circular dichroism (XMCD) in the AFM state of Mn_3Sn [3]. The spin operator term in XMCD, the so-called S_z term, should be negligibly small as well as the net magnetization. However, it is clarified that the anisotropic magnetic dipole (AMD) operator term, the so-called T_z term, remains uncancelled in the AFM order and is linked to the augmented (cluster) magnetic octupole (see Figure). Based on this prediction, XMCD experiments were performed on bulk crystals of Mn_3Sn. As a result, we succeeded in observing XMCD at Mn-L absorption edge and demonstrated that the XMCD signal is purely coming from the T_z tern by its magnetic field and incident angle dependence and comparing with theoretical calculations of the spectrum [4].



REFERENCES

1. S. Nakatsuji, N. Kiyohara, and T. Higo, Nature 527, 212 (2015).
2. T. Higo, et al., Nat. Photonics 12, 73 (2018).
3. Y. Yamasaki, H. Nakao, T. Arima, J. Phys. Soc. Jpn. 89, 083703 (2020)
4. M. Kimata, Y. Yamasaki, Tetsuya Nakamura, *et al*., Nat. Commun. 12, 5582 (2021)