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Helicities of Magnetic Skyrmion Lattices Studied by Circularly Polarized Resonant X-ray Scattering

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In noncentrosymmetric magnetic materials, various types of nontrivial magnetic structures are realized as a result of competing interactions of symmetric magnetic exchange interaction, Dzyaloshinskii-Moriya type antisymmetric exchange interaction, and Zeeman energy in external magnetic fields, especially in Gd and Eu compounds with weak crystal field anisotropy. In many cases, they are non-collinear or non-coplanar structures associated with incommensurate spiral ordering. In this talk, we focus on the tetragonal EuTGe_3 family without an inversion center but with mirror planes including the c -axis (space group $I4mm$). From our recent studies on EuIrGe_3 , EuNiGe_3 , and EuRhGe_3 , using circularly polarized resonant X-ray diffraction to investigate magnetic helicities, it was clarified that each compound exhibits distinctive ordering phenomena reflecting competing interactions. In EuIrGe_3 , successive transitions take place from sinusoidal ($m \parallel c$) to cycloidal ($m \parallel ac$ or bc) structures with a tiny reorientation of the propagation vector from $q=(0, 0, 0.792)$ to $(0.017, 0, 0.792)$. Each of the four cycloidal domains has its own helicity. In EuNiGe_3 , single- q helical ordering at zero field with $q=(0.26, 0.053, 0)$ transforms into a triple- q distorted triangular skyrmion lattice state in a magnetic field. Surprisingly, the original helicity at zero field is reversed to form a skyrmion lattice with unified helicity. In EuRhGe_3 , in contrast, the helical order propagating along the c -axis is free from the antisymmetric interaction.

REFERENCES

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