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The Absolute Direction of the Dzyaloshinskii-Moriya Interaction in Hematite Determined by Polarized Neutron Diffraction

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Polarized neutron diffraction (PND) is a powerful method which provides direct access to the scattering contribution from nuclear-magnetic interference and thus reveals the phase difference between the nuclear and magnetic structure. This technique can be utilized to gain a detailed insight in the microscopic spin ordering at the unit cell level even for complex magnetic structures. Since magnetic domains correspond to an overall phase shift between the nuclear and magnetic structure, PND also allows to resolve different magnetic domain configurations providing additional information at the mesoscopic scale. This qualifies PND as a versatile tool to simultaneously address a wide range of scientific issues. By conducting a detailed PND study of the prototypical room-temperature weak ferromagnet α-Fe_2O_3 (hematite) we could solve the long standing problem of inconsistent asymmetry signs observed within Friedel pairs in hematite. Moreover, using a detailed symmetry analysis the absolute direction of the Dzyaloshinskii-Moriya interaction (DMI) vector in α-Fe_2O_3 could be determined for the first time. This study is supported by a detailed refinement of the slightly canted magnetic structure and by numerical calculations. It can be used as a reference for further DMI sign determinations, reducing the experimental efforts to the measurement of one representative reflection, making it well suited for highly topical materials often requiring extreme sample environment.

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