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Neutron scattering study of magnetism in HoFeO3

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Rare-earth orthoferrites, RFeO3 where R is Y or rare earth elements with perovskite structure exhibit intriguing magnetic properties, including non-collinear structures and magnetic phase transitions due to a combination of antiferromagnetic (AFM) exchange interactions and Dzyaloshinsky-Moriya (DM) anti-symmetric exchange interactions, which make them promising candidates for innovative spintronic applications. Starting from the paramagnetic state at high temperatures, Fe3+ ions order antiferromagnetically at high temperatures (˜600 K) [1]. With further cooling many rare-earth orthoferrites undergo spin-reorientation transitions where the direction of the net magnetic moment rotates from one crystallographic axis to another primarily due to the antisymmetric and anisotropic-symmetric exchange interactions between Fe3+ and R3+. Among different orthoferrites, HoFeO3 is of interest as optical measurements indicate the magnetic splitting of the crystal field (CF) ground state doublet of the Ho3+ ion is located directly in the antiferromagnetic–resonance frequencies of the Fe subsystem [2]. However a complete understanding of its magnetic properties including spin-reorientation transitions, exchange interactions among different magnetic ions, and the crystal field schemes for the lowest J-levels of the Ho3+ ions is still lacking. Here we report the results of our neutron scattering study of HoFeO3. Our inelastic experiments indicate the presence of at least three CF excitations below 30 meV at energy levels different from the indirect estimates obtained from heat capacity measurements. We also identify three temperatures associated with the Fe3+ spin-reorientation transitions in this material.

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Primary author: YAMANI, zahra (CNL)

Co-authors: Prof. RYAN, Dominic (Physics Department, McGill University); Prof. STEWART, Glen (UNSW, AUSTRALIA)

Presenter: YAMANI, zahra (CNL)

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