Structural, magnetic ordering process and the magnetic excitations in spinel FeMn2O4

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Spinel FeMn2O4 has been reported to exhibit a rough cation distribution of (Mn2+)A(Mn3+Fe3+)BO4, with Mn2+ mainly occupying the tetrahedral (A) sites forming a diamond lattice, and Fe3+ and Mn3+ sharing the octahedral (B) sites randomly to form a pyrochlore lattice. Powder neutron diffraction reveals a cubic-tetragonal structural transition at ~595 K upon cooling due to the Jahn-Teller distortion of MnO6 octahedra. A collinear ferrimagnetic order with antiparallel moments along c axis between A and B sites is found below ~373 K, and non-collinear ferrimagnetic order induced by the spin canting at B site appears below ~50 K. At 8 K, we observe a spin gap of approximately 5 meV arising from single-ion anisotropy at the orbitally active Mn3+ site. Spin wave dispersions in both the collinear and non-collinear ferrimagnetic ordered regions have been mapped out via inelastic neutron scattering on large single crystals. We demonstrate that the orbital degree of freedom of B-site Mn3+ ion and its coupling to spin and lattice degrees of freedom play a key role in the structural and magnetic properties in FeMn2O4.