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Magnetic phase transitions in frustrated epsilon-Fe_2O_3 polymorph

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The epsilon phase of Fe_2O_3 (ε-Fe_2O_3) presents captivating properties and it is receiving extraordinary attention due to its great application potentials. It stands out for its huge coercive field (up to 2 T at room temperature), millimeter-wave ferromagnetic resonance, remarkable non-linear magneto-optical effect, magnetoelectric coupling [1], and room temperature ferroelectricity [2]. It has been much less studied than other iron (III) oxides because its formation requires special conditions [1].
ε-Fe_2O_3 presents a complex noncentrosymmetric structure ($Pna2_1$) with three distinct octahedral and one tetrahedral environments for Fe sites. We present a neutron-based investigation on the rich magnetic phase diagram and properties of geometrically frustrated ε-Fe_2O_3 nanoparticles. The nature of the incommensurate magnetic order, attributed by some authors to a spiral ground state [5], was investigated in zero and applied magnetic fields, and reinterpreted in the light of the models confronted to neutron data [6]. The study illustrates the interplay between the huge magnetic anisotropy, frustration and the stabilization of the super-hard ferrimagnetic phase in the 150-500 K interval.

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