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A new interpretation of the Besnus transition in monoclinic pyrrhotite

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Non-stoichiometric monoclinic 4C pyrrhotite (ideal formula: Fe7S8) is a major magnetic remanence carrier in the Earth's crust and in extraterrestrial materials. Because of its low-temperature magnetic transition around 30 K also known as Besnus transition, this mineral phase is easily detectable in natural samples. Considering the rock magnetic literature, an intrinsic origin of the Besnus transition similar to that of the Verwey transition has generally been assumed. Although the physical properties of pyrrhotite have intensively been studied, the mechanism behind the pronounced change in magnetization at the low-temperature transition is still debated.
To address this question we performed magnetization experiments on a natural pyrrhotite crystal (Fe6.6S8) that consists of an epitaxial intergrowth of a commensurate 4C and an incommensurate 5C* superstructure that are different in their defect structure (1,2). The occurrence of two monoclinic superstructures detected by X-ray diffractometry is magnetically confirmed by symmetric inflection points in hysteresis measurements above the transition at about 30 K. The disappearance of the inflection points and the associated change of the hysteresis parameters indicate that the two superstructures become strongly coupled to form a unitary magnetic anisotropy system at the transition. From this it follows that the Besnus transition in monoclinic pyrrhotite is an extrinsic magnetic phenomenon with respect to the 4C superstructure and therefore the physics behind it is in fact different from that of the well-known Verwey transition.
Finally, this novel interpretation explains the rock magnetic data for the low-temperature transition that has been reported for monoclinic pyrrhotite. It will also provide deeper understanding of magnetism in monoclinic pyrrhotite, which in turn will enable a more profound insight to the magnetization properties of the Earth's crust.

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2.) Koulialias, D., Kind, J., Charilaou, M., Weidler, P.G., Löffler, J.F. & Gehring, A.U. 2016. Geophys. J. Int., 204, 961-967.