Magnetism of novel $Nd_2Ir_2O_7$-type compound

F. Hájek,[1] M. S. Henriques,[2] D. Staško,[1] Q. Faure,[3] K. Vlášková,[1] J. Kaštil,[2] O. R. Fabelo Rosa,[4] E. Lhotel,[3] and M. Klicpera[1]

[1] *Charles University, Faculty of Mathematics and Physics, Department of Condensed Matter Physics, Ke Karlovu 5, 121 16 Prague 2, Czech Republic*

[2] *Institute of Physics of the Czech Academy of Sciences, Na Slovance 1999/2, 182 21 Prague 8, Czech Republic*

[3] *University Grenoble Alpes, Institut Néel 25 av. des Martyrs BP166, 38042 Grenoble Cedex 9, France*

[4] *Institute Laue-Langevin, 71 avenue des Martyrs, CS 20156, Cedex 9, Grenoble 38042, France*

Rare-earth $A_2Ir_2O_7$ oxides constitute a family of compounds that is attractive due to their complex properties and application potential. The geometrically frustrated pyrochlore lattice hosts Ir^{4+} ions with strong spin-orbit coupling and electron correlations of comparable strength, thereby paving the way for exotic magnetic and topological phenomena. In combination with crystal-field effects and significant f-d exchange between the rare-earth and iridium sites, this leads to the emergence of, e.g., an antiferromagnetic Weyl semimetal state [1], fragmented spin ice with monopole-like excitations [2] and spin liquid states [3,4]. Moreover, the existence of these complex phases is inherently tied to the tetrahedral network of the pyrochlore lattice.

Our present work focusses on the A = Nd member of the series. In its pyrochlore form $Nd_2Ir_2O_7$ exhibits two magnetic transitions – the Ir sublattice orders at ∼35 K in the all-in-all-out (AIAO) configuration and induces the same configuration on the Nd sublattice at ∼9 K. By introducing Pb in the synthesis process, we prepared single crystals of a new $Nd_2Ir_2O_7$-type compound, denoted NIO. Although this phase is tetragonal ($I4_1/a$), it retains key structural characteristics of the cubic pyrochlore structure ($Fd\bar{3}m$). We investigate this compound by means of magnetisation and specific heat measurements, demonstrating close similarities between NIO and $Nd_2Ir_2O_7$. Furthermore, X-ray and neutron single crystal diffraction are employed to determine the crystallographic and magnetic structures, thereby shedding light on the magnetic properties of NIO.

References:

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