Chiral Spin Liquid Ground State in $YBaCo_3FeO_7$

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A chiral spin liquid state is discovered in the highly frustrated, non-centro symmetric swedenborgite compound $YBaCo_3FeO_7$, a layered kagome system of hexagonal symmetry, by advanced polarized neutron scattering from a single domain crystalline sample. The observed diffuse magnetic neutron scattering has an antisymmetric property that relates to its specific chirality, which consists of three cycloidal waves perpendicular to the $\boldsymbol{c}$-axis, forming an entity of cylindrical symmetry. Chirality and symmetry agree with relevant antisymmetric exchanges arising from broken spatial parity. Applying a Fourier analysis to the chiral interference pattern, with distinction between kagome sites and the connecting trigonal interlayer sites of three-fold symmetry, the chiral spin correlation function is determined. Characteristic chiral waves originate from the trigonal sites and extend over several periods in the kagome-planes. The chiral spin liquid is remarkably stable at low temperatures despite strong antiferromagnetic spin exchange. The observation raises a fundamental challenge, since the commonly accepted ground states in condensed matter either have crystalline long-range order or form a quantum liquid. Based on the fundamental theory of classical magnetic order, we show that a disordered ground state may arise from chirality. The antisymmetric exchange acting as a frustrating gauge background stabilises local spin lumps. This scenario has similarities to the avoided phase transition in coupled gauge- and matter-fields for sub-nuclear particles.[1]

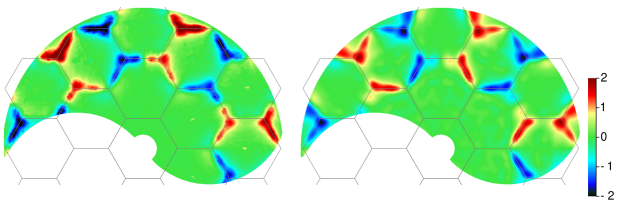

Figure 1: The anti-symmetric part of polarized diffuse neutron scattering from a single domain crystal of $YBaCo_3FeO_7$ at T=4K reveals a pattern of 3-fold symmetry that is related to cycloidal chirality. (left) The normalized and observed chiral scattering $S^{yz}_{\mathbf{Q}}$, which is defined as the Fourier transform of the tensor of the full chiral correlation function, (right) Modeled chiral scattering based on cycloidal chiral correlations obtained by Fourier analysis.

[1] W. Schweika, M.Valldor, J. Reim, U.K. Rößler, Chiral Spin Liquid Ground State in $YBaCo_3FeO_7$, Phys. Rev. X 12, 021029 (2022).