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Non-trivial Spin Structures and Multiferroic Properties of the DMI-Compound $Ba_2CuGe_2O_7$

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Antiferromagnetic $Ba_2CuGe_2O_7$, characterized by a quasi-2D structure with Dzyaloshinskii-Moriya interactions (DMI), is a material that exhibits spiral spin structures with potential non-trivial topology and combines them with a variety of unconventional magnetic phase transitions. $Ba_2CuGe_2O_7$ is an insulator characterized by a tetragonal, non-centrosymmetric space group ($P\bar{4}2_1m$). The main features of the magnetic structure are due to the Cu2+ ions in a square arrangement. Below the Néel temperature T_N = 3.05K, the DMI term leads to a long-range incommensurate, almost AF cycloidal spin spiral in the ground state.
Recently, a new phase with a vortex-antivortex magnetic structure has been theoretically described and experimentally confirmed in a pocket in the phase diagram at around 2.4K and an external field along the crystalline c-axis of around 2.2T. A lack of evidence for a thermodynamic phase transition towards the paramagnet in high resolution specific heat measurements and a finite linewidth in energy and momentum of the incommensurate peaks in neutron scattering, as opposed to the cycloidal ground state, seem to mark the vortex phase as a slowly fluctuating structure at the verge of ordering. Polarization measurements and neutron experiments including E-field in order to investigate its interplay with an external magnetic field are already planned and will allow for further pinning down multiferroic properties of $Ba_2CuGe_2O_7$.

Primary author: WILD, Peter

Co-authors: FELLNER, Korbinian (TU München); Prof. GARST, Markus (Karlsruhe Institue of Technology); DEMBSKI-VILLALTA, Michal; MUEHLBAUER, Sebastian

Presenter: WILD, Peter

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