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Magnetic dynamics in the single-domain state of the cubic helimagnet ZnCr2Se4

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Anisotropic low-temperature properties of the cubic helimagnet ZnCr₂Se₄ in the single-domain spin-spiral state are investigated by a combination of neutron scattering, thermal conductivity,and dilatometry measurements. In an applied magnetic field, neutron spectroscopy shows a complex and nonmonotonic evolution of the spin-wave spectrum across the quantum-critical point that separates the spin-spiral phase from the field-polarized ferromagnetic phase at high fields. A tiny spin gap of the pseudo-Goldstone magnon mode, observed at wave vectors that are structurally equivalent but orthogonal to the propagation vector of the spin helix, vanishes at this quantum critical point, restoring the cubic symmetry in the magnetic subsystem. The anisotropy imposed by the spin helix has only a minor influence on the lattice structure and sound velocity, but has a much stronger effect on the heat conductivities measured parallel and perpendicular to the magnetic propagation vector. Anisotropic thermal transport is magnetic in origin and highly sensitive to an external magnetic field. We also report long-time thermal relaxation phenomena, revealed by capacitive dilatometry, which are due to magnetic domain motion related to the destruction of the single-domain magnetic state. Our results can be generalized to a broad class of helimagnetic materials in which a discrete lattice symmetry is spontaneously broken by the magnetic order.

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