Contribution ID: **72** Type: **Poster**

Pseudo-Goldstone Magnons in the Frustrated S=3/2 Heisenberg Helimagnet ZnCr2Se4 with a Pyrochlore Magnetic Sublattice

Tuesday, 18 September 2018 17:15 (15 minutes)

Low-energy spin excitations in any long-range ordered magnetic system in the absence of magnetocrystalline anisotropy are gapless Goldstone modes emanating from the ordering wave vectors. In helimagnets, these modes hybridize into the so-called helimagnon excitations. Here we employ neutron spectroscopy supported by theoretical calculations to investigate the magnetic excitation spectrum of the isotropic Heisenberg helimagnet ZnCr2Se4 with a cubic spinel structure, in which spin-3/2 magnetic Cr3+ ions are arranged in a geometrically frustrated pyrochlore sublattice. Apart from the conventional Goldstone mode emanating from the (0 0 qh) ordering vector, low-energy magnetic excitations in the single-domain proper-screw spiral phase show soft helimagnon modes with a small energy gap of ~0.17 meV, emerging from two orthogonal wave vectors (qh 0 0) and (0 qh 0) where no magnetic Bragg peaks are present. We term them pseudo-Goldstone magnons, as they appear gapless within linear spin-wave theory and only acquire a finite gap due to higher-order quantum-fluctuation corrections. Our results are likely universal for a broad class of symmetric helimagnets, opening up a new way of studying weak magnon-magnon interactions with accessible spectroscopic methods.

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Session Classification: Poster session 2

Track Classification: P4 Magnetism and quantum phenomena