Experimental report

10/04/2018

Proposal: 4-01-1466 **Council:** 4/2015

Title: The role of frustrated interchain interaction for the continuum scattering in a Haldane chain

Research area: Physics

This proposal is a continuation of 4-01-1138

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Samples: CsNiCl3

Instrument	Requested days	Allocated days	From	To
IN20	15	12	05/11/2015	19/11/2015

Abstract:

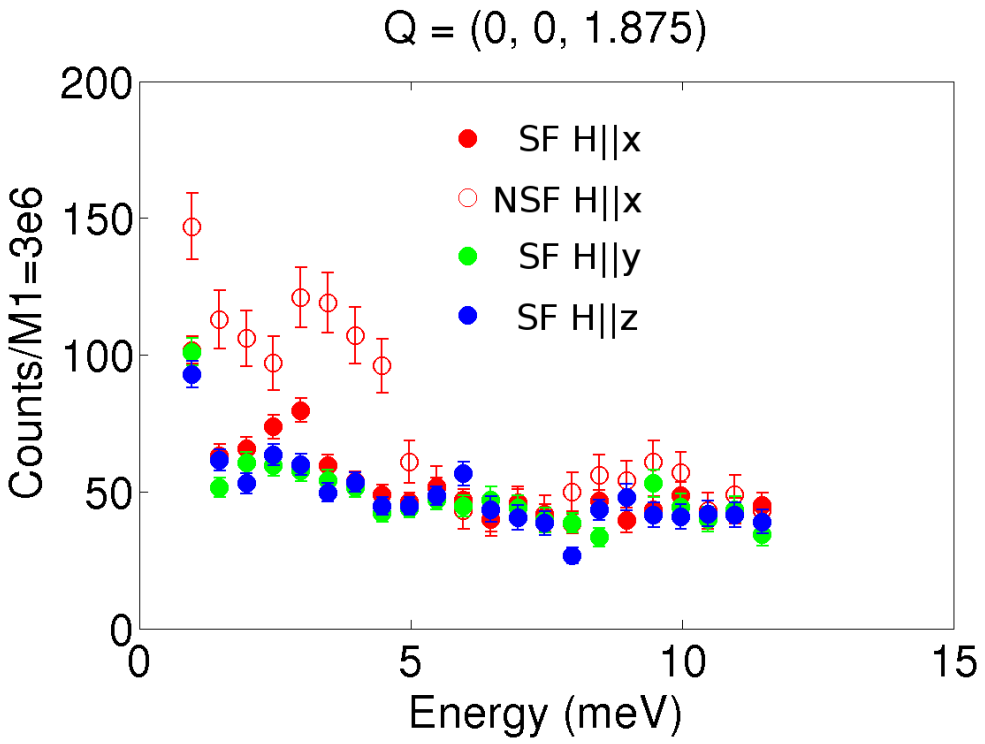
CsNiCl3 is the only spin-1 Heisenberg antiferromagnetic chain compound (Haldane chain) where sizable magnetic continuum scattering has been observed, absent in other intensely studied Haldane materials. We suspect that this enhanced continuum scattering is related to the strength of the multiply frustrated interchain interactions. Part of this frustration should be lifted as a function of temperature along with the decrease of one-dimensional correlations. In order to evidence the unusual temperature dependence of the effective interchain interaction in this compound, we propose to study the interchain dispersion as a function of temperature, along with the 1D bandwidth, in order to extract the interchain coupling strength as a function of temperature.

IN20 was configured with Heusler(111) monochromator and analyser, both horizontally focused, W-scattering sense, PG(002) filter in k_f, and standard polarised setup (Helmholtz coils). The $\sim$ 1 cm^3 single crystal of $CsNiCl_3$ was aligned in the (h, h, ℓ) scattering plane and inserted into a standard Orange cryostat. The sample height was adjusted via a Friedel pair of nuclear reflections. The vertical remanent field was compensated by -0.42A in the vertical Helmholtz coil for polarised cross sections with horizontal guide field at the sample. We worked with $k_f = 2.662$Å^{-1} fixed throughout the experiment. The flipping ratio on the nuclear Bragg peak (110) at 10 K was 20, on an acoustic phonon at 3 meV energy transfer and temperature 200 K it was 15.

Polarised data were taken at the 3D magnetic zone center, the 1D zone center, and the 1D zone boundary, as a function of temperature, at $T = 1.5$ K, 6 K, 12.5 K, 25 K, 50 K in order to study the influence of the interchain coupling on the purely magnetic spectra above T_N.

We find a clear dependence of the magnetic response on the wave vector perpendicular to the one-dimensional antiferromagnetic chains even at temperatures five times higher than T_N, and at energies well below k_BT.

Part of the beamtime was spent to verify the published asymmetry of the 1D-dispersion, measured with unpolarised neutrons [Zaliznyak PRL 87, 017202 (2001)]. We identify a phonon in the dispersion range where broadening was reported, cf. figure 1.



Energy scan at $Q = (0, 0, 1.875)$ where a broadening of the magnetic excitation was reported with respect to $Q = (0, 0, 1.225)$. The NSF channel with $H||x$ clearly shows a phonon, while the magnetic scattering, fully visible in the SF channel with $H||x$, appears at lower energy than the phonon. Phonon and magnetic scattering would appear superposed in unpolarised data like those shown in [Zaliznyak PRL 87, 017202 (2001)].