Contribution ID: **24** Type: **multiferroics and chirality**

Spin waves in full-polarized state of Dzyaloshinskii-Moriya helimagnets: polarized SANS study

Wednesday, 26 February 2025 11:00 (30 minutes)

The cubic noncentrosymmetric structure of the B20 compounds causes the formation of a spin spiral with a wave vector $k_s = D/J$ balanced by the competition of antisymmetric Dzyaloshinskii-Moriya (DM) interaction and the ferromagnetic exchange interaction (Back-Jensen model) [1,2]. The application of a magnetic field H transforms the helix into a conical structure, which collapses into a field-induced ferromagnet at point H_{C2}. This field is defined by the interaction hierarchy through $g_B H_{C2} = Ak_s^2$, where $A = J/S$ is the spin-wave stiffness. This ratio between H_{C2}, A and k_S was experimentally tested for a large number of B20 compounds: MnSi [3], $Mn_{1-x}Fe_xSi$ [4], FeGe [5], $Mn_{1-x}Fe_xGe$ [6], $Fe_{1-x}Co_xSi$ [7,8],Cu_2OSeO_3 [9]. The above ratio was proven to be valid for all the above mentioned compounds within the whole temperature range from 0 to T_C. To order to perform these experimental tests, we develop a technique to study the spin wave dynamics of the full-polarized state of the Dzyaloshinskii-Moriya helimagnets by polarized small-angle neutron scattering. We have experimentally proven that the spin waves dispersion in this state has the anisotropic form given by M.Kataoka in [10]: $\epsilon_q = A(\mathbf{q}–\mathbf{k}_s)^2 + g\mu_B(H–H_{C2})$. We show that the neutron scattering image displays a circle with a certain radius, which is centered at the momentum transfer corresponding to the helix wave vector in helimagnetic phase $\mathbf{k}_s$, which is oriented along the applied magnetic field H. The radius of this circle is directly related to the spin-wave stiffness A of this system. This scattering depends on the neutron polarization showing the one-handed nature of the spin waves in Dzyaloshinskii-Moriya helimagnets in the full-polarized phase. Thus the spin wave stiffness A can be measured in the fast mode in the wide temperature range and for a large variety of samples. We have found that the spin-wave stiffness A change weakly with temperature for each individual compound but remarkable is a change of A with the concentration x for the $Mn_{1-x}Fe_xSi$ compounds [4] and for the $Fe_{1-x}Co_xSi$ compounds [8]. A detailed picture of these changes and their interpretations will be reported.

References:

[1] P. Bak, M.H. Jensen, J. Phys. C13 (1980) L881.
[2] O. Nakanishi, A. Yanase, A. Hasegawa, M. Kataoka, Solid State Commun. 35 (1980) 995.
[3] S. V. Grigoriev, A. S. Sukhanov, E. V. Altynbaev, S.-A. Siegfried, A. Heinemann, P. Kizhe, and S. V. Maleyev, Phys. Rev. B 92, 220415(R) (2015).
[4] S. V. Grigoriev, E. V. Altynbaev, S.-A. Siegfried, K. A. Pschenichnyi, D. Menzel, A. Heinemann, and G. Chaboussant, Phys. Rev. B 97, 024409 (2018).
[5] S.-A. Siegfried, A. S. Sukhanov, E. V. Altynbaev, D. Honecker, A. Heinemann, A. V. Tsvyashchenko, and S. V. Grigoriev, Phys. Rev. B 95, 134415 (2017).
[6] S. V. Grigoriev, E. V. Altynbaev, S.-A.Siegfried, K. A. Pshenichnyi, D. Honnecker, A. Heinemann, A. V. Tsvyashchenko, JMMM 459, 159-164 (2018).
[7] S. V. Grigoriev, K. A. Pshenichnyi, E. V. Altynbaev, S.-A. Siegfried, A. Heinemann, D. Honnecker, and D. Menzel, JETP Letters, 107, No. 10, pp. 640–645 (2018).
[8] S. V. Grigoriev, K. A. Pschenichnyi, E. V. Altynbaev, S.-A. Siegfried, A. Heinemann, D. Honnecker, and D. Menzel, Phys. Rev. B 100 N. 9 pp. 094409 (2019)
[9] S. V. Grigoriev, K. A. Pschenichnyi, E. V. Altynbaev, A. Heinemann, and A. Magrez, Phys. Rev. B 99, 054427(2019)
[10] M. Kataoka, J.Phys.Soc.Jap. 56, 3635 (1987).

Primary author: GRIGORYEV, Sergey (NRC "Kurchatov Institute" - Petersburg Nuclear Physics Institute)

Presenter: GRIGORYEV, Sergey (NRC "Kurchatov Institute" - Petersburg Nuclear Physics Institute)

Track Classification: Download the latest program here