Contribution ID: **25** Type: **Oral**

Equilibrium states of antiferromagnetic ring-shaped and helix-shaped spin chains with hard-tangential anisotropy

Wednesday, 5 December 2018 10:45 (20 minutes)

For the last decade, active research on magnetic nanosystems of curved geometry was motivated by their outstanding properties and great application potential [1]. For instance, recent theoretical studies of low-dimensional magnets with complex geometry propose a description of fascinating geometry-induced effects including pattern formation and magnetochiral effects in quasi-one-dimensional wires [2], for review see [1]. Despite these advances in the study of curvilinear low-dimensional ferromagnets, significant knowledge gaps exist in the study of curvilinear antiferromanetic systems.

The purpose of the current study is the theoretical investigation of equilibrium states in antiferromagnetic ring-shaped and helix-shaped spin chains with hard-tangential anisotropy. For this purpose we use both analytical methods and computer spin-lattice simulations in SLaSi software package [3]. In our study, we consider two sublattice antiferromagnet in the frame of the sigma-model approach where its statics and dynamics are described in terms of Neel vector only.

We analytically show that the global energy minimum of the antiferromagnetic ring-shaped spin chain is reached when Neel vector is perpendicular to the ring plane. An equilibrium phase diagram is constructed for the antiferromagnetic helix-shaped spin chain: (i) a quasi-binormal state is realized in the case of relatively large curvatures and (ii) spatial-periodic state is typical in the opposite case. Both states are described analytically and well confirmed by SLaSi.

Stability regions of both ground states are determined using spin-lattice simulator SLaSi.

[1] R. Streubel, P. Fischer, F. Kronast, V. P. Kravchuk, D. D. Sheka, Y. Gaididei, O. G. Schmidt and D. Makarov, J. Phys. D, 49, 363001, (2016).

[2] D. D. Sheka, V. P. Kravchuk, Y. Gaididei, J. Phys. A, 48, 125202, (2015).

[3] http://slasi.knu.ua/

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Session Classification: Condensed Matter Physics

Track Classification: Condensed Matter Physics