SEMINAR ON MAGNETISM AND SUPERCONDUCTIVITY

We kindly inform You that on **Wednesday**

October 18th at 10:00

there will be a **seminar in room 203, building I**

where

Mr Dey Jaydeb

(Institute of Physics PAS)

will deliver a lecture on:

"Magnetic ordering in nanolaminated Mn_2GaC MAX Phase thin film: NMR Study"

Magnetic $M_{n+1}AX_n$ (MAX) materials, composed of transition metals (M), IIIA or IVA group elements (A), and carbon or nitrogen (X) in one to three layers (n), have been a decade-long focus of research. Among these, Mn_2GaC, synthesized as a nanolaminated thin film, stands out as the first magnetic MAX phase with a single M-element species at its M-sites. This reduces chemical disorder compared to previous quaternary MAX phases, which featured two atomic species at these sites.

Mn_2GaC possesses hexagonal symmetry ($P6_3/mmc$ space group) and consists of atomically laminated Mn-C-Mn slabs stacked along the hexagonal c-axis, interleaved with gallium atomic layers. Its magnetic order-disorder transition temperature has been reported as 507 K, with a magneto-structural phase transition at around 214 K, below which the magnetic structure has not been fully defined. Theoretical studies indicate complex magnetic structures involving competing ferromagnetic (FM) and antiferromagnetic (AFM) interactions. Experimental evidence from unpolarized neutron reflectometry suggests fully compensated long-range AFM order ($AFM[0001]_4^A$) in Mn_2GaC films, while macroscopic magnetic measurements indicate the presence of remanent magnetization.

To solve these ambiguities, ^{55}Mn Nuclear Magnetic Resonance (NMR) studies were conducted at 4.2 K on a 100 nm thin film of MgO (111)/Mn_2GaC under zero-field (ZF) conditions and various in-plane magnetic field values. ZF ^{69,71}Ga NMR data revealed a large effective field at Ga (≈15.75 T) due to uncompensated magnetic moments from neighboring Mn atoms, indicating a non-collinear magnetic structure [1]. ZF ^{55}Mn NMR detected magnetically non-equivalent Mn positions, with an average magnetic moment of $\cong 2\,\mu_B$ / Mn-atom. In-field NMR experiments showed a continuous distribution of magnetic moment orientations from 0° to 180°, representing a helical magnetic structure along the c-axis (perpendicular to the film plane). This helical structure, deduced from NMR data analysis, arises from competing ferro-antiferro exchange interactions between supermoment layers and features an incommensurate pitch with up to 14 crystal lattice period [2].

[1] J. Dey, M. Wójcik, E. Jędryka, R. Kalvig, U. Wiedwald, R. Salikhov, M. Farle, and J. Rosén, Non-collinear magnetic structure of the MAX phase Mn_2GaC epitaxial films inferred from zero-field NMR study (CE-5: L05), Ceram. Int. 49, 24235 (2023).
[2] J. Dey, E. Jędryka, R. Kalvig, U. Wiedwald, M. Farle, J. Rosen, and M. Wójcik, Helical magnetic structure of epitaxial films of nanolaminated Mn_2GaC MAX phase, Phys. Rev. B 108, 054413 (2023).

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The seminar will be given in English on-site in room 203, though the ZOOM transmission will be available - link is provided on the IP PAS website.

We sincerely invite You
Roman Puźniak / Andrzej Szewczyk / Henryk Szymczak