Piątek, 27.02.2026 godz. 11:00

KFN Neutron Webinar

KFN Neutron Webinar: Monthly lectures on neutron research – informative, inspiring and interconnecting.

KFN Neutron Webinar

Upcoming programme

Universality, criticality and competing classically magnetic frustrated phases: The role of spectroscopy @ ESS

Prof. Dr. Pascale Deen

ESS and Nils Bohr Institut, University of Copenhagen
Friday, **27 February 2026**, 11:00 - 12:00 CET

A primary focus of condensed matter physics has been on understanding the ordered states within materials. Associated phase transitions are often described by Ginzburg–Landau and renormalisation group theory in which a compound is expected to follow a spontaneous symmetry breaking across a transition temperature [1,2].

Some systems do not order so easily due to competing interactions that cannot be simultaneously satisfied. These conflicting interactions are collectively referred to as frustration. This scenario leads to the emergence of phases of matter where conventional ordering phenomena are significantly suppressed or may never occur, while allowing for the emergence of other unusual order and disorder phenomena [3].

We turn our attention to classical magnetic compounds that show a strong frustration index and order at a reduced temperature, with respect to the Curie Weiss temperature. Novel emergent states of matter are observed across a broad temperature range developing below the transition temperatures and extend deep into the paramagnetic regime, contrary to the theoretical framework of phase transitions.

We present the examples of hexagonal h-$YMnO_3$ and the quasi two-dimensional Cairo pentagonal lattice $Bi_2Fe_4O_9$ as two frustrated magnetic compounds that reveal diffuse but correlated magnetic correlations and continuous fluctuations below TN and deep into the paramagnetic regime. We present the relevant exchange interactions in the ordered phase that drive magnetic frustration and the diffuse spin-wave spectrum that develops for T < TN and extends for T >> TN [4-8]. The neutron scattering signatures can be understood using a combination of first-principles density functional calculations and spin-dynamics simulations to reveal clusters of emerging order. In the case of h-$YMnO_3$ the magnetic order can be visualised in terms of composite trimer magnetoelectric monopoles and toroidal moments, instead of individual spins [9]. These results provide new insight into the magnetic phase transitions of frustrated systems and the requirements on neutron spectroscopy and data analysis for our future instruments to access these unusual phases.

[1] K. G. Wilson, Rev. Mod. Phys. 47, 773 (1975). [2] Modern Theory Of Critical Phenomena (2018): Taylor & Francis. Shang-keng Ma. [3] C. Lacroix, P. Mendels, F. Mila (eds.), Introduction to Frustrated Magnetism, Springer (2011). [4] S. Holm et al. Phys. Rev. B 97, 134304 (2018) [5] S. Janas et al. Phys. Rev. Lett. 126, 107203 (2021) [6] K. Beauvois. et al. Phys. Rev. Lett. 124, 127202 (2020) [7] Manh Duc Le et al. Park. Phys. Rev. B 104, 104423 (2021) [8] E. Y. Lenander et al. Phys. Rev. B 113, 014424 (2026) [9] T. Tosic et al. Phys. Rev. Lett. 6, L042037 (2024)

Dr. Martin Boehm

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