MS24-02 | Spiral Spin-Liquid, Multi-Step Order and the Emergence of a Vortex-Like State in $MnSc_2S_4$

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$MnSc_2S_4$ spinel with magnetic Mn^{2+} ions forming the diamond lattice is anexcellent model material for study magnetic frustration conceiving exotic states such as spiral spin liquid, competing long-range ordered phases and triple-q state in applied magnetic fields [1]. Neutron diffuse scattering gives direct experimental evidence for the existence of the spiral spin liquid (T_{N1}=2.2 K <T< T_{cw}=23 K), which was predicted to occur in the J_1-J_2 model on the diamond lattice, when the ratio between the ferromagnetic first and antiferromagnegtic second neighbour couplings is $|J_2/J_1|$>0.125 [2]. Neutron single crystal diffraction unravels three long-range ordered phases supplanting each other on temperature lowering (T_{N1}=2.2 K, q_1=3/4 3/4 0; T_{N2}=1.75 K, q_2=3/4+d 3/4-d 0; T_{N3}=1.6 K, q_3=q_1) and, from the field variation of intensities of the different q_3 arms discloses the triple-q state. With Monte Carlo simulations we scrutinize further details of the spin Hamiltonian, i.e. the third neighbour coupling, single ion anisotropy and exchange anisotropy and establish that this set of parameters indeed stabilizes the lattice of dense topological objects akin to skyrmions [3].

[1] S. Gao, O. Zaharko, V. Tsurkan, et al. Nature Physics, 13, 157 (2016).
[2] D. Bergman, J. Alicea, E. Gull, S. Trebst, L. Balents, Nature Physics 3, 487 (2007).
[3] S. Gao, D. Rosales, V. Tsurkan, O. Zaharko, et al. in preparation.