

Department of Physics

Condensed Matter Physics

Clarendon Laboratory, Parks Road, Oxford OX1 3PU



CONDENSED MATTER SPECIAL SEMINAR

Wednesday 12 July at 11:00

“How many spin liquids are there in $\text{Ca}_{10}\text{Cr}_7\text{O}_{28}$?”

Prof Nic Shannon

Okinawa Institute of Science & Technology, Japan

$\text{Ca}_{10}\text{Cr}_7\text{O}_{28}$ is an exotic new magnetic insulator, in which spin-1/2 Cr^{5+} ions form bilayers of a breathing–Kagome lattice. Exchange interactions in $\text{Ca}_{10}\text{Cr}_7\text{O}_{28}$ are confined to bilayers and predominantly ferromagnetic, with a Curie temperature of 2.35 K [1,2]. None the less, no magnetic order is observed down to 19 mK, making $\text{Ca}_{10}\text{Cr}_7\text{O}_{28}$ an unusual example of a two-dimensional quantum spin liquid [1].

In this talk we explore the nature and origin of the spin liquid observed in $\text{Ca}_{10}\text{Cr}_7\text{O}_{28}$, starting from the microscopic model of magnetic interactions proposed by Balz. et al. [1,2]. Using semi-classical molecular-dynamics simulations, we characterise the evolution of spin dynamics in $\text{Ca}_{10}\text{Cr}_7\text{O}_{28}$ in applied magnetic field, making explicit comparison with published inelastic neutron scattering data.

To our surprise, we find that excitations encode not one, but two distinct types of spin liquid, a “spiral spin liquid” similar to that studied in square-lattice frustrated ferromagnets [3], and a coulombic spin liquid previously observed in the Kagome-lattice antiferromagnet [4]. We argue that the zero-field quantum spin-liquid ground state in $\text{Ca}_{10}\text{Cr}_7\text{O}_{28}$ is born out of the “spiral spin liquid”, and interpret scattering at finite energy in terms of the pinch-points of the coulombic spin liquid. We also offer a simple explanation of the spiral spin liquid behaviour, through a mapping onto an effective spin-3/2 honeycomb lattice model [5].

[1] C. Balz. et al., Nat. Phys. 12, 942 (2016)

[2] C. Balz. et al., Phys. Rev. B 95, 174414 (2017)

[3] L. Seabra et al., Phys. Rev. B 93, 085132 (2016)

[4] D. A. Garanin and B. Canals, Phys. Rev. B 59 443 (1999)

[5] H. Yan, R. Pohle and N. Shannon, in preparation.

Host: Prof Radu Coldea

Martin Wood Lecture Theatre, Clarendon Laboratory