Department of Physics
Condensed Matter Physics
Clarendon Laboratory, Parks Road, Oxford OX1 3PU

UNIVERSITY OF OXFORD

CONDENSED MATTER SEMINAR

Thursday 20 June at 2.15pm

"Quantum Criticality in Ferromagnets"

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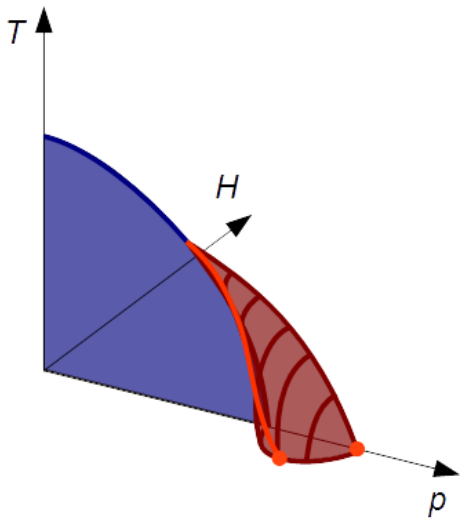
Phase transitions are a very old concept in thermodynamics. The thermal fluctuations at a second-order phase transition give rise to critical behavior. In the limit of zero temperature, however, thermal fluctuations are absent and second-order phase transitions are dominated by quantum fluctuations due to Heisenberg's uncertainty principle. Such a case is called a quantum critical point. Here, I present our work on ferromagnetism that is suppressed towards a quantum critical point.



In the transition metal compound NbFe2 we follow the suppression of 2nd order ferromagnetic order in the search for a quantum critical point (QCP) – a continuous phase transition at zero temperature. QCPs in ferromagnetic (FM) metals impose a long-standing challenge including seemingly incompatible temperature dependencies in transport and thermodynamic properties. In many of these systems, the FM QCP is avoided through a change to 1st order. Here, we present results on a second class of FM quantum critical metals in which the QCP is avoided through an intervening spin-density-wave (SDW) phase. We show that the phase diagram of NbFe2 can be modelled with a two-order-parameter theory in which the FM QCP is buried within a SDW phase, as proposed by Moriya and Usami1. This model reproduces detailed magnetisation measurements on high-purity single crystals for a series of samples tuned across the buried FM QCP via variations in the composition. We establish the presence of quantum tricritical points at which both the uniform and finite wavelength susceptibility diverge, which offer an explanation for the seemingly incompatible temperature dependencies 2.

1. Moriya, T. & Usami, K. Coexistence of ferro- and antiferromagnetism and phase transitions in itinerant electron systems. Solid State Commun. 23, 935–938 (1977).
2. Friedemann, S. et al. Quantum tricritical points in NbFe2. Nat. Phys. 14, 62–67 (2018).

Host: Pascal Reiss

Simpkins Lee Room, Beecroft Building