QUANTUM CRITICALITY IN $NbFe_2$

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Quantum phase transitions and the associated critical behaviour provide a successful guiding principle towards novel forms of electronic self-organisation. While examples of quantum critical behaviour abound in 4f-electron metals, such as the heavy fermion Ce- and Yb-compounds, comparatively few transition metal compounds have been studied in detail, most notably the nearly or weakly ferromagnetic materials MnSi, Ni_3Al/Ni_3Ga, ϵ-Fe and $ZrZn_2$, as well as layered oxides such as the high-T_c cuprates and the ruthenates.

We present an investigation of the C14 Laves phase $NbFe_2$, which has been reported as a rare example of low temperature spin density wave order ($T_N \simeq 10$ K) among the d-metal compounds [1]. The low temperature state of $NbFe_2$, which develops out of incipient ferromagnetism with a record Stoner enhancement factor of about 150, can be tuned by slightly modifying the composition within the narrow Nb-Fe homogeneity range [2]. Slight Fe-excess induces low-moment ferromagnetism, whereas a quantum critical point ($T_N \rightarrow 0$) is approached on the Nb-rich side (for $\simeq Nb_{1.01}Fe_{1.99}$).

We report non-Fermi liquid power-law forms in the electrical resistivity with exponents approaching $1.5 - 1.7$ at low temperatures for polycristalline and single crystal samples across the homogeneity range. Moreover, in slightly Nb-rich $NbFe_2$, which shows no evidence of bulk magnetic order, we find strongly temperature dependent Sommerfeld coefficients of the heat capacity $C/T \sim \log T$ over more than a decade in temperature [3]. These findings, which point at the existence of an effectively ferromagnetic quantum critical point in slightly Nb-rich $NbFe_2$, are discussed with reference to related f- and d-metal compounds.

[1] Y. Yamada and A. Sakata, J. Phys. Soc. Japan 57 (1988) 46; M. M. Crook *et al*, J. Magn. Magn. Mater. 140 (1995) 71. [2] M. Brando et al., Physica B 378-380 (2006) 111. [3] M. Brando et al., JMMM (2006) In Press.