Pressure dependence of tricriticality in $UIrSi_3$

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Abstract

Applying a magnetic field to an antiferromagnet can cause abrupt changes to its magnetic state. A metamagnetic transition to a paramagnetic state is accomplished in sufficiently high magnetic fields. This transition is usually of the second order. However, a first-order transition is observed at low temperatures well below the Néel temperature in some cases. The antiferromagnet - paramagnet transition line in the field-temperature magnetic phase diagram, having the first-order and second-order type segments, this is expected in Ising antiferromagnets with competing antiferromagnetic and ferromagnetic interactions. D. P. Landau has interpreted the point at which the two segments meet as a tricritical point (TCP) [1]. The TCP is observed only rarely in uranium compounds, for example, in $UIrSi_3$, [2], UIrGe [3], UAu_2Si_2 [4], USb_2 [5], UNiAl [6].

We will present a pressure study on $UIrSi_3$ single crystal. At ambient pressure, the Neél temperature (T_N) is 42 K. When the magnetic field is applied along the c-axis (easy magnetization axis), the AFM order is suppressed by the metamagnetic transition (MMT) at H_C = 7.3 T at 2 K, while a polarized paramagnetic phase emerges. At low temperatures, the metamagnetic transition is first-order type. In temperatures above 28 K, the hysteresis disappears; first-order type of the transition changes to the second-order type. The point at which the transition changes is TCP [2,7]. Applying pressure shifts H_C to a lower magnetic field, whereas the temperature of TCP (T_{TCP}) gradually increases as T_N (Fig. 1). The critical pressure for H_C = 0 T is estimated to be 8.6 GPa; the dependences of $T_N(p)$ and $T_{TCP}(p)$ merge near 9.5 GPa.

The pressure evolution of characteristic properties of $UIrSi_3$ and other uranium compounds is driven by magnetoelastic interactions. The presentation will discuss the origin of these phenomena and the underlying physics beyond critical pressures.

[1] D. P. Landau, Physical Review Letters 28 (1972) 449.

[2] J. Valenta et al., Physical Review B 97(2018)144423.

[3] J. Pospíšil et al., Physical Review B 98 (2018) 014430.

[4] M. Vališka et al, Physical Review B 98 (2018) 174439.

[5] R. L. Stillwell et al., Physical Review B 95 (2017) 014414.

[6] E. Brück et al., Physical Review B 49 (1994) 8852.

[7] F. Honda et al., Physical Review B 100, 014401, (2019)

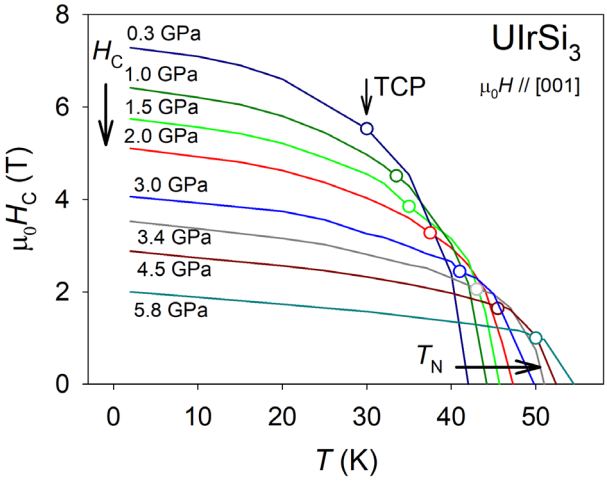

Fig. 1: Field-temperature phase diagram with enriched by result under high pressure.