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Competition of Hidden Order and Antiferromagnetism in URu_2Si_2 under Pressure

ELENA HASSINGER, INAC, CEA Grenoble, France

URu_2Si_2 is a heavy fermion compound with an ordered phase below $T_0 = 17.5$ K at ambient pressure. The signature of the transition at T_0 in macroscopic quantities is very large and indicates a partial gap opening on the Fermi surface. However, the order parameter could not be identified yet and therefore, the phase is called hidden order (HO). Additionally, the compound becomes superconducting below $T_{sc} = 1.4$ K. Here, we[1] focus on the difference between HO and the pressure induced antiferromagnetic state (AF) in order to shed light on the HO itself. By specific heat and resistivity measurements under pressure[2], we were able to confirm the pressure-temperature phase diagram determined by neutron scattering[3]. For pressures higher than $P_c = 0.5$ GPa the antiferromagnetic phase develops and superconductivity is suppressed at the same time. The transition line between HO and AF can be seen as a small anomaly in resistivity and specific heat data until 1.3 GPa, where it seems to join the transition line between the paramagnetic and the HO phase. The nesting-like signature at T_0 in resistivity surprisingly does not change qualitatively between low pressures at the transition to HO and high pressures at the transition to the AF. The differences in the low energy excitations between the HO and AF phases have been investigated by neutron scattering measurements at 0.67 GPa[4], where three phases can be detected on cooling: paramagnetic, HO and AF phase. The inelastic response at the antiferromagnetic wavevector $Q_0 = (1, 0, 0)$ and at the position of the second minimum in the dispersion relation $Q_1 = (1.4, 0, 0)$ was measured in the three distinct phases. The sharp excitation at Q_0 with a gap of 1.8 meV exists only in the hidden order phase and disappears in the antiferromagnetic phase whereas the excitation at Q_1 persists in both phases. Therefore only the excitations at the commensurate wavevector Q_0 are characteristic of the HO phase.

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