FIELD-INDUCED FERMI SURFACE RECONSTRUCTION AND ADIABATIC CONTINUITY BETWEEN ANTIFERROMAGNETISM AND HIDDEN-ORDER STATE IN URu_2Si_2

Y.J. Jo (NHMFL, CME); L. Balicas (NHMFL, CME); C. Capan (LSU, Physics) K. Behnia (EPSCI, Paris); P. Lejay (CRTBT, Grenoble); J. Flouquet (CEA, Grenoble); J.A. Mydosh (U. Cologne. I. Physics II); and P. Schlottmann; (FSU, Physics)

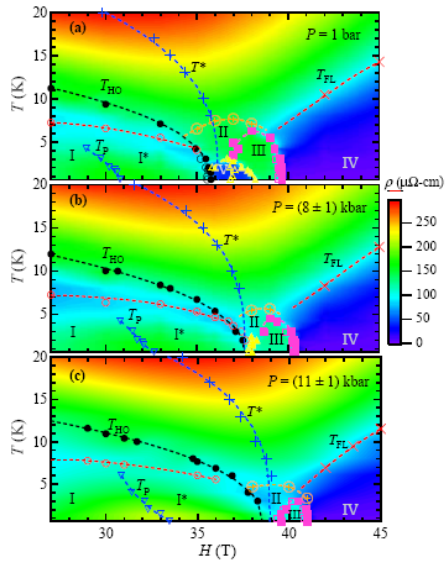
Introduction

The nature of the phase emerging at T_0 ~ 17.5 K which coexists with antiferromagnetism in URu_2Si_2 remains elusive and has been called the ``hidden-order'' (HO) state. None of the theoretical scenarios proposed can explain satisfactorily all the available data. In this Letter we present high field, low temperature electrical transport measurements in URu_2Si_2 under high hydrostatic pressure in order to gain insight on the interplay between the AFM and HO phases.

Experimental

We performed electrical transport measurement at very low temperatures by using the portable dilution fridge as well as hydrostatic pressure measurements using a ^{3}He insert in conjunction with the hybrid magnet [2].

Results and Discussion



(a) The resulting H-T phase-diagram of URu_2Si_2 at p = 1 bar, shown for comparative purposes. The phase-boundary towards the HO state (phase I, following the nomenclature of Ref. [1]) is indicated by black dots. The position of a minimum in ρ within the HO-state is indicated by red circles. The position of the maximum observed in ρ within the HO state at T_p and where the geometry of the Fermi surface changes significantly is indicated by blue triangles. We nominate this new phase as phase I*. The boundary of the reentrant HO state (or phase III) is defined by magenta squares, while the boundaries of phases II and V are defined respectively, by orange circles and yellow triangles. The recovery of a FL state at T_{FL} is indicated by red crosses. Finally, the crossover from positive to negative magnetoresistance within the higher temperature metallic state is indicated by blue crosses. (b) Same as in (a) but under a pressure p = 8 ± 1 kbar. (c) Same as in (a) but for a pressure p = 11 ±

Conclusions

Our observations favor a scenario where the evolution from HO to AFM under pressure is a crossover rather than a phase transition with two competing coupled order parameters in the mixed phase, i.e., an adiabatic continuity between HO and AFM with gradual change in their weight with field and pressure. The picture of the HO-state emerging from this study indicates a semi-metallic state containing an intrinsic dipolar component which has FS pockets enclosing a volume of ~ 1.5 % of the Brillouin zone. It becomes slightly more metallic (in agreement with the Hall effect) under field, as indicated from the increased FS cross-sections in the SdH oscillations at T_p, then into a sequence of field-induced phases (which are shifted to higher fields and lower temperatures under pressure), and finally into the metallic FL phase IV. This increase in the density of carriers and the coexistence between HO and AFM is difficult to reconcile with a purely local crystalline field picture. Pressure increases the direct overlap between 5*f*-orbitals of nearest neighbor U-ions. This should favor an AFM phase.

Acknowledgements

YJJ acknowledges the NHMFL Schuller .postdoctoral program while LB acknowledges support the NHMFL in-house research program.

References

[1] Jo, Y.J., *et al.* ,submitted to Phys. Rev. Lett.