Fermi surface instabilities in ferromagnetic superconductors

Alexandre Pourret[1,2], A. Gourgout [1,2], G. Bastien[1,2], .G. Knebel[1,2], Dai Aoki[1,2,3] and Jacques Flouquet[1,2]

[1] *University Grenoble Alpes, INAC-PHELIQS, F-38000 Grenoble, France*
[2] *CEA, INAC-PHELIQS, F-38000 Grenoble, France*
[3] IMR, Tohoku University, Oarai, Ibaraki 311-1313, Japan

In highly correlated electron systems where the relevant energy scales are considerably reduced due to the strong correlations of the partially filled *f* shells, the ground state is easily tunable under the influence of an external parameter such as pressure or magnetic field. One of the main issue is to understand the interplay of Fermi surface instabilities, magnetic fluctuations and quantum criticality through the competing orders which appears in these systems. Among them, two compounds are particularly interesting, UCoGe and URhGe, because they show the coexistence of two "antagonist" states of matter, ferromagnetism and superconductivity. The most fascinating aspect in UCoGe is the peculiar dependence of the critical field called "S-shape", for URhGe, it is the apparition of a new superconducting phase under magnetic field (around 12T). Recently, we put emphasis on the important role of Fermi surface on the transport properties in these systems. Indeed, in UCoGe, several successive anomalies were observed under magnetic field (along the easy magnetization c-axis) in resistivity, Hall effect and thermoelectric power, without any thermodynamic transition. The direct observation of quantum oscillations showed that these anomalies are related to topological changes of the Fermi surface, also known as Lifshitz transitions [1]. In URhGe with the field applied along the hard magnetization *b*-axis, a drastic change in the Fermi surface at the spin reorientation field (H_R = 11.75 T) has been observed through thermoelectric power measurements [2]. Additionally, this study allows us to confirm the first order character of the transition and to locate precisely the tricritical point in this compound. This work appears as a pioneering work to understand the effect of magnetic polarization on the Fermi surface topology in highly correlated electron systems.

[1] G. Bastien, A. Gourgout, D. Aoki, A. Pourret et al., "Lifshitz Transitions in the Ferromagnetic Superconductor UCoGe ", Phys. Rev. Lett. 117, 206401 (2016)

[2] A. Gourgout, A. Pourret, et al., "Collapse of Ferromagnetism and Fermi Surface Instability near Reentrant Superconductivity of URhGe", Phys. Rev. Lett. 117, 046401 (2016)