

# Superconductivity and magnetism of heavy fermion systems: some open problems !

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In this talk, I will present some open problems related to the magnetism and superconductivity of heavy fermion systems, for which a new generation of measurements at ESRF under extreme conditions of temperature, field and pressure might be very helpful.

A first question is related to the question of quantum critical points: in heavy fermion systems, they are easily controlled by pressure, and it is usually believed that going from the magnetic to non-magnetic phase in cerium compounds is accompanied by a change of regime from localized to delocalized 4f electrons. Besides this “valence change” problem, analysis of the upper critical field around a quantum critical point can lead to valuable information on the pairing mechanism. This analysis could be constrained if a microscopic knowledge of the Zeeman coupling (gyromagnetic factor) of Cooper pairs was available, which would both yield information on the parity of the superconducting order parameter (singlet or triplet...) and indirectly on the coupling strength.

Another hot subject is the understanding of ferromagnetic quantum critical points, controlled by pressure, with field induced “metamagnetic like transitions”: this topic is a very fundamental problem, and XMCD would again yield the most relevant data on the magnetization of the systems, which is lacking in the present measurements.

Last but not least, we will present the case of uranium superconducting ferromagnets (URhGe, UCoGe) which require exploring very low temperatures and high field magnetic properties, and require a microscopic probe to unveil the driving mechanism of re-entrant superconducting phases.