PhD or PostDoc position
in Solid State Physics for synchrotron based experiments

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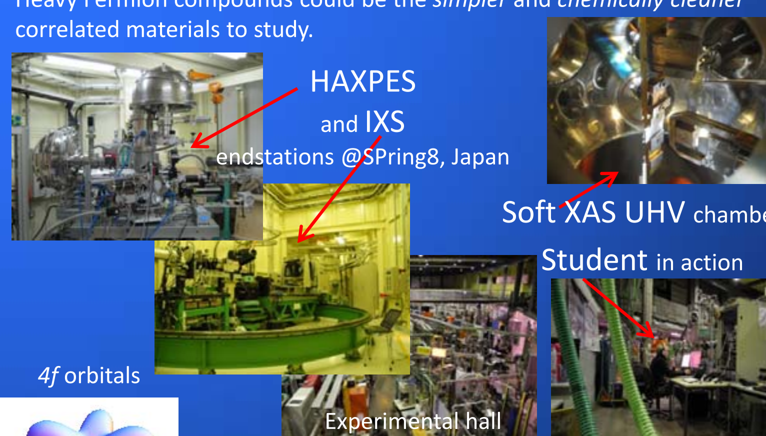
Metallic rare earth compounds are ideal systems to study the interplay between magnetism and superconductivity. The electrons triggering the magnetic properties are the *4f* electrons and they are close to the atom so that the moments can be derived from Hund's rules. However, in a certain class of Ce and Yb materials the localized magnetic electrons become more itinerant with particular consequences. For example, some of their properties are transferred to the conduction electrons by hybridization, resulting in slow moving conduction electrons: these conduction electrons can have enhanced effective masses up to three orders of magnitude larger than in the free electron gas.

ESRF in Grenoble, France

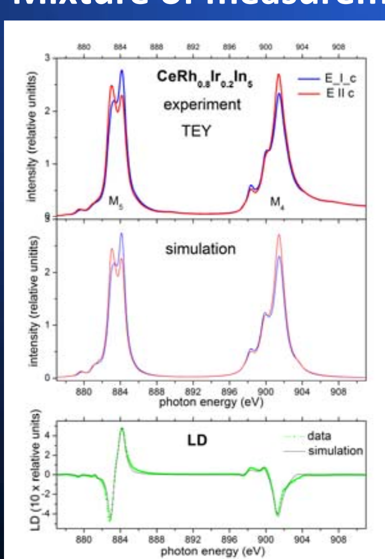
Diamond, Oxford, UK

In some of these so called *Heavy Fermion* compounds the hybridization of *4f* and conduction electrons leads to the loss of magnetic moments in analogy to the Kondo effect in diluted systems (Kondo lattice materials), other Heavy Fermions exhibit non-conventional superconductivity and/or quantum critical phenomena, or order antiferromagnetically at low temperatures. Not only the proximity of superconductivity and magnetism is intriguing but also the important question remains why among chemically and structurally similar compounds some are superconducting and/or Kondo-like, and others are antiferromagnetic. Heavy Fermion materials can further serve as model materials thanks to certain similarities to the high T_c cuprate superconductors. In Heavy Fermion materials the size of the Fermi surface changes at the Kondo-break-down in the vicinity of the quantum critical point in analogy to the Mott insulator to metal transition in the high Tc cuprates. Yet, the Heavy Fermion compounds could be the *simpler* and *chemically cleaner* correlated materials to study.

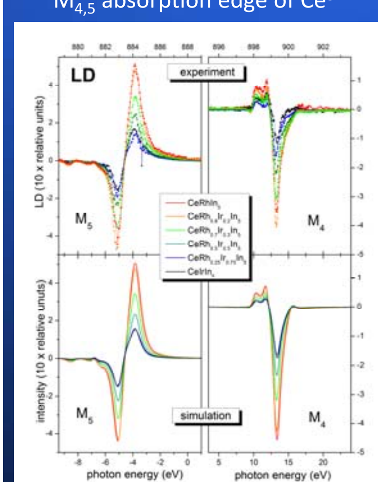
It seems generally accepted that quantum critical and/or magnetic fluctuations are a necessity to form Copper pairs in these materials, but a general description of how these superconducting states with their non-isotropic order parameters form does not yet exist. Hence, there is a clear need for further investigating properties such as **symmetry**, **occupation**, **energy scales** etc. of the electronic states, or more specifically, of the *4f* states involved. Spectroscopic tools like soft M-edge XAS, N-egde NIXS, L-edge RIXS and RXES, HAXPES, and INS enable us to determine these properties. The experiments are performed at various synchrotron facilities worldwide, i.e. we measure at HZB-BESSY in Berlin, NSRRC in Taiwan, Spring-8 in Japan, ESRF in Grenoble and SOLEIL in Saclay, both in France, or at neutron facilities like ISIS in Oxfordshire, UK or ILL in Grenoble, France. The extensive data analysis is performed in Cologne. Many of our efforts are in close collaboration with the spectroscopy group of Prof. L.-H. Tjeng at the Max-Planck Institute for Chemical Physics of Solids in Dresden.



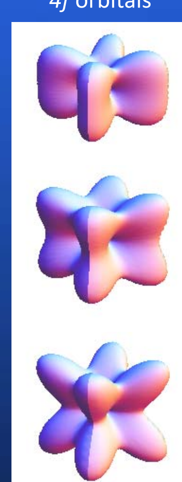
Mixture of measurement and modeling



$M_{4,5}$ absorption edge of Ce^{3+}



4f orbitals



Here we do our experiments:

@Soleil – Paris, France @ESRF – Grenoble, France
@Diamond – Oxford, UK @BESSY HZ Berlin,
@NSRRC - Taiwan @SPring-8 - Japan