O 29: Symposium: Surface Spectroscopy on Kondo Systems I (Invited Speakers: Wolf-Dieter Schneider, Fakher Assaad, Serguei Molodtsov)

Time: Tuesday 11:15–13:30 Location: HE 101

Invited Talk O 29.1 Tue 11:15 HE 101

From single magnetic adatoms to two-dimensional Kondo lattices: A local view — •Wolf-Dieter Schneider — EPFL, Institut de Physique des Nanostructures, CH-1015 Lausanne, Switzerland

The unique ability of scanning tunneling microscopy and spectroscopy to address an individual atom on a surface has contributed considerably to our understanding of fundamental excitations and interactions at the atomic level. Here we present a few case studies from our laboratory. These include the detection of the Kondo effect at magnetic adatoms [1], the observation of very-low-energy adsorbate vibrations [2] revealing a surprising similarity with the spectroscopic signatures of Kondo scattering and spin-flip excitations, the manifestation of local disorder within a Ce-adatom superlattice on Ag(111) in its two-dimensional (2D) electronic bandstructure, and the 2D melting via a hexatic phase of a Ce-adatom superlattice on Cu(111). In such superlattices, depending on the relative strength of Kondo scattering versus RKKY interactions, ferromagnetic or antiferromagnetic adatom pairs at different separations may be formed leading to exciting magnetic properties of such artificial nanostructures. These results provide illustrative examples in the emerging fields of nanoscience and nanotechnology for the characterisation and the controlled engineering of physical properties at the single atom level.

[1] J. Li, W.-D. Schneider, R. Berndt, and B. Delley, Phys. Rev. Lett. 80, 2893 (1998).

[2] M. Pivetta, M. Ternes, F. Patthey, and W.-D. Schneider, Phys. Rev. Lett. 99, 126104 (2007).

Invited Talk O 29.2 Tue 11:45 HE 101

The Kondo Lattice in two dimensions: numerical studies of the Fermi surface. — •Fakher F. Assaad, Kevin S.D. Beach, and Lee C. Martin — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany

The Kondo lattice model on a square lattice is the simplest model capturing the physics of heavy fermion materials. Below the coherence temperature and in the paramagnetic phase, it describes the heavy fermion metallic state which is characterized by a large Fermi surface with Luttinger volume incorporating both the conduction electrons and the localized moments. In this talk we will review recent results aimed at understanding the evolution and breakdown of this Fermi surface as function of temperature, magnetic field as well as across a magnetic order-disorder transition. Our results stem from large scale Quantum Monte Carlo simulations in the framework of the Dynamical Cluster Approximation.

Invited Talk O 29.3 Tue 12:15 HE 101

ARPES Study of Hybridization Phenomena in Heavy-Fermion Lanthanide Compounds — •Serguei Molodtsov — Dresden University of Technology, Germany

High-resolution angle-resolved photoemission spectra of various heavy-fermion Ce and Yb systems reveal strong momentum (k) dependent splittings of the 4f signals around the expected intersection points of the 4f final states with valence bands in the Brillouin zone [1]. The obtained dispersion of the interacting 4f states both in the region of the Fermi level and at higher binding energies is explained in terms of a simplified periodic Anderson model by a k dependence of the electron hopping matrix element disregarding clearly interpretation in terms of the single-impurity Anderson model for single-crystalline samples. The obtained data show that the heavy-fermion behavior depends crucially on properties of the electronic bands not necessarily located in the immediate vicinity of the Fermi energy.

[1]. S. Danzenbaecher et al. Phys. Rev. B 72 (2005) 033104; Phys. Rev. Lett. 96 (2006) 106402; D.V. Vyalikh et al. Phys. Rev. Lett. 96 (2006) 026404; Phys. Rev. Lett. (2007), accepted.

O 29.4 Tue 12:45 HE 101

k- and spin-dependent hybridization effects in Ce monolayer — •Yury Dedkov[1], Denis Vyalikh[1], Mikhail Fonin[2], Yury Kucherenko[3], Serguei Molodtsov[1], and Clemens Laubschat[1] — [1]Institut für Festkörperphysik, TU Dresden, Germany — [2]Fachbereich Physik, Universität Konstanz, Germany — [3]Institute for Metal Physics, Kiev, Ukraine

Here we present applications of the periodic Anderson model (PAM) to consideration of wave vector (**k**)- and spin-dependent hybridization effects in Ce metal. It was shown that **k**-dependent splitting of the $4f$ ionization peak of Ce/W(110) are correctly described in the framework of the PAM (Coulomb repulsion between two f electrons localized on the same lattice site $U_{ff} \rightarrow \infty$). Our results show that the wave vector is conserved upon hybridization. In case of the magnetically ordered Ce monolayer, spin- and angle-resolved resonant photoemission spectra reveal spin-dependent changes of the Fermi-level peak intensities (which reflect the hybridization strength). That indicate a spin-dependence of $4f$ hybridization and, thus, of $4f$ occupancy and local moment. The phenomenon was also described in the framework of PAM by $4f$ electron hopping into the exchange split Fe $3d$ derived bands that form a spin-gap at the Fermi energy around the $\overline{\Gamma}$ point of the surface Brillouin zone.

O 29.5 Tue 13:00 HE 101

High-Resolution Photoemission Spectroscopy on an Ordered Pt_5Ce Surface Alloy: Kondo-Resonance, Band Structure and Fermi Surface — •Christina Albers[1], Markus Klein[1], Kevin Beach[2], Fakher Assaad[2], and Friedrich Reinert[1] — [1]Universität Würzburg, Experimentelle Physik II, 97074 Würzburg — [2]Universität Würzburg, Theoretische Physik I, 97074 Würzburg

We present a detailed investigation of the electronic structure of an ordered Pt_5Ce-film by means of angular resolved ultraviolet photoemission spectroscopy (ARUPS). An *in situ* prepared, ordered Pt_5Ce surface alloy, consisting of alternating layers of Pt_2Ce and kagome-nets of Pt, forms stable and reproduceable films on the Pt substrate. We investigated in detail the $4f$ Kondo resonance, other renormalization effects on the k-dependent band structure, and the temperature-dependence of the spectral features. In particular we studied the $4f$-states by a comparison of the data on Pt_5Ce and Pt_5La. The experimental results will be discussed together with DMFT calculations.

O 29.6 Tue 13:15 HE 101

FeSi - Kondo insulator or itinerant system? — •Dirk Menzel[1], Markus Klein[2], Damian Zur[1], Klaus Doll[3], Friedrich Reinert[2], and Joachim Schoenes[1] — [1]Technische Universität Braunschweig, Institut für Physik der Kondensierten Materie — [2]Universität Würzburg, Lehrstuhl für Experimentelle Physik II — [3]Max-Planck-Institut für Festkörperforschung, Stuttgart

The claim that FeSi is the first Kondo insulator containing no f-electrons [1] resulted in an intense discussion about the nature of this material. However, recent theoretical and experimental investigations have generated more and more arguments for an interpretation of apparently uncommon electronic properties in an itinerant band model. We have performed angle-resolved high-resolution photoemission spectroscopy on FeSi single crystals using a He spectral lamp as well as synchrotron radiation. The photoemission spectra agree qualitatively with the bandstructure derived from single-particle GGA calculations. However, we could also observe strong renormalization effects near the valence band maximum. A quantitative consistency can be obtained when an interaction among the Fe-d-electrons is added to the calculations in the form of self energy corrections. The resulting spectral function is in surprisingly good accordance to the experimental data. These results support the interpretation of FeSi as an itinerant material with d-correlations without the necessity of including Kondo interactions.

[1] G. Aeppli and Z. Fisk, Comments Cond. Mat. Phys. **16**, 155 (1992).