DUAL NATURE OF 5f ELECTRONS IN URANIUM COMPOUNDS: A PHOTOEMISSION STUDY

T. Durakiewicz[1], J.J. Joyce[1] and C.G. Olson[2]
[1] Los Alamos National Laboratory, Los Alamos, New Mexico 87544, USA
[2] Ames Laboratory, Iowa State University, Ames, Iowa 50011, USA

Due to the presence of unfilled 5f electron shell, several interesting physical properties are observed in light actinide compounds. A variety of ground states, including magnetism and superconductivity are found [1]. Among light actinides, compounds based on depleted Uranium are allowed in public synchrotron facilities. These compounds are suitable for studying the effects of correlations in f-electron systems. In the strongly correlated systems one faces multiple and competing interactions that complicate the description and make the data reduction and interpretation process difficult. Due to the limited amount of success in theory of such systems, duality of *f* electrons in 5*f* materials was proposed as a possible starting point, and the idea was tested experimentally. One of the consequences of duality is the ability of the 5*f* electron to participate in the conduction band and remain localized simultaneously. From the electronic structure point of view, this results in part of the 5*f* spectral weight being found in dispersive and hybridized bands in vicinity of the Fermi level, whereas some other part of 5*f* electrons remain localized. Examples from photoemission experiments on several Uranium systems will be shown, and selected aspects of duality will be discussed, with emphasis on the electronic structure and ground state properties. Attempts to link ground state properties to the electronic structure will also be presented. Valence electronic structure of light actinides is strongly influenced by hybridization with 5f electrons, which results in band renormalization and the occurrence of a high density of states near the Fermi level. This part of the valence band determines the electronic specific heat or transport properties of the material. Features seen at higher binding energies are in turn correlated with magnetic properties, e.g. magnetic moment [2]. The detailed nature of this latter relationship remains unknown and some possible explanations will be proposed. Most interesting in this respect is the dual nature of 5f electrons, which can be both partially localized and contribute to narrow, dispersive bands thus showing itinerant behavior. Examples of 5f itinerant magnets [3] and superconductors will be shown, together with their measured and calculated electronic structures.

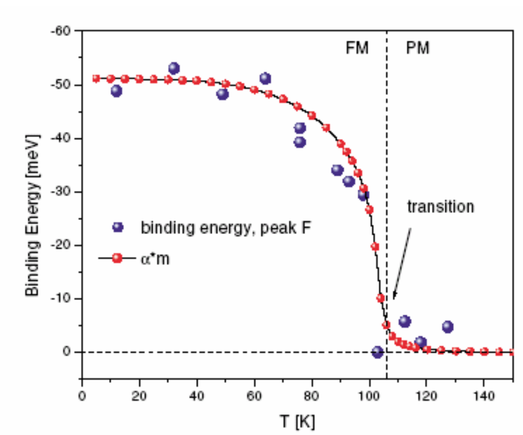

Fig. 1: The movement of the 5f character band towards the Fermi level in the ferromagnet UTe (blue dots) correlates with magnetisation (red dots) – example of the itinerant5f character[3].

This work is supported by the U.S. Department of Energy, Office of Science, Division of Materials Science and Engeneering. The SRC is operated under Grant No. DMR-0084402.

References:

[1] Sarrao *et al.*, ***Nature*** **420** (2002) 297.
[2] Durakiewicz *et al.*, ***Phys. Rev. B*** **70** (2004) 205103.
[3] Durakiewicz *et al.*, ***Phys. Rev. Lett.*** **93** (2004) 267205.