# ARPES Studies of Selected Cerium Heavy Fermion Systems

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**Abstract.** Hybridization between Cerium 4f electrons and conduction band leads to various interesting phenomena such as a Kondo effect, formation of heavy fermions or valence fluctuations. It may also play an important role in a realization of quantum phase transitions. Such a hybridization - $V_{cf}$ may have a nontrivial form including a dependence on a wave vector. It is reflected in a spectral function, which can be registered with angle-resolved photoemission spectroscopy (ARPES).

We studied different Cerium intermetallics, which exhibit properties of heavy fermion systems. $Ce_2Co_{0.8}Si_{3.2}$ has increased specific heat coefficient of C/T =200 mJ/(mole$_{Ce}$ K$^2$) and shows the properties of a Kondo lattice below 80 K. Two other systems, $CeCoIn_5$ and $Ce_3PdIn_{11}$ are also heavy fermion materials with a transition to a superconducting state at 2.3 K and 0.42 K, respectively. Their specific heat coefficient amounts to 290 and 550 mJ/(mole$_{Ce}$ K$^2$) for $CeCoIn_5$ and $Ce_3PdIn_{11}$, respectively. Such large values of the Sommerfeld coefficient indicate that strong $V_{cf}$ hybridization effects should be present in the investigated systems.

Band structure of $Ce_2Co_{0.8}Si_{3.2}$ was scanned by ARPES along $\bar{\Gamma} - \bar{Y} - \bar{\Gamma}$ direction [1]. Both surface and bulk states are found in the spectra. Intensity of a coherent peak related to 4f electrons, which is observed near Fermi energy ($E_F$), varies considerably along the Fermi surface. This fact can be explained by matrix element effects and anisotropic $V_{cf}$ hybridization.

Electronic structure of $CeCoIn_5$ was mapped with Ce 4d-4f resonance (122 eV) and off resonance (84 eV) photon energy. Both energies correspond to similar semi-planar cuts of Brillouin zones in a vicinity of Γ point. The ARPES studies realized in different experimental geometry reveal matrix element effects. Moreover, evidence of $V_{cf}$ hybridization is reflected in the spectra in the energy scale of ~ 8 meV. One can distinguish narrow bands and highly correlated bands with a large spectral width. Contribution of f-electrons also depends on the region of Fermi surface.

On resonance (122 eV) ARPES mapping of $Ce_3PdIn_{11}$ revealed more complex Fermi surface as compared to $CeCoIn_5$. Strong deviations from non-interacting dispersions lead to large effective mass bands observed near $E_F$.

**Acknowledgments**
This work was supported by the project CEDAMNF, reg. no. CZ.02.1.01/0.0/0.0/15_003/0000358, co-funded by the European Regional Development Fund (ERDF).

**References**
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