Defects, Density of States and Differential Conductance in Heavy-Fermion Materials

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Defects have proven to be invaluable microscopic probes for exploring complex properties of strongly correlated electron systems, such as the cuprate superconductors. Recent breakthroughs in scanning tunneling spectroscopy (STS) of heavy-fermion materials have opened the possibility for utilizing defects also in this class of materials.

In this talk, I demonstrate that defects can provide important insight into the electronic and magnetic structure of heavy-fermion materials. In particular, I show that defects perturb the electronic and magnetic correlations of these systems in a qualitatively different way, allowing one to discriminate between them in real space. These perturbations possess spectroscopic signatures, such as in the differential conductance, dI/dV, measured by STS, and thus are experimentally accesible. Moreover, I demonstrate that the dI/dV lineshape is determined by quantum interference between different tunneling paths, but that the local density of states can nevertheless be extracted from it. Finally, I discuss the qualitative different effects of various types of defects, and explore the possibility for interference driven quantum phase transitions that reflect the strong non-linear behavior of heavy-fermion materials.