A Nanoscopic Approach to Heavy Fermions: from Kondo droplets to Kondo Holes

Dirk K. Morr
University of Illinois at Chicago

Heavy fermion materials exhibit a plethora of unconventional phenomena, ranging from a *hidden order state* to *quantum criticality*. The key to understanding the microscopic origin of these phenomena lies in elucidating the complex electronic and magnetic structure of these materials, a task that has long been proven elusive. Recently, two groundbreaking, complementary approaches to this problem have been pioneered using scanning tunneling spectroscopy. While nanoscopic replicas of heavy-fermion materials, so-called *Kondo droplets*, have provided unprecedented control in manipulating Kondo screening at the nanoscale, defects in heavy fermion materials have been utilized to explore the nature of the strong correlations in real space.

In this talk, I will present a theoretical discussion of these new approaches and demonstrate that they allow us to gain exceptional insight into the correlated electronic and magnetic structure of heavy fermion materials. In particular, I will show that Kondo droplets provide a unique opportunity to locally study the competition between Kondo screening and magnetic ordering which are at the heart of the heavy fermion problem. Moreover, I will demonstrate that defects induce perturbations in the electronic and magnetic structures that possess characteristically different spatial patterns and directly reflect the strength of correlations. As a result, it is possible to disentangle electronic and magnetic correlations in real space.