

# Novel theoretical approaches to the Fermi polaron problem

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In this talk, I will present our recent work on developing a unified theory that connects the quasiparticle picture of Fermi polarons for mobile impurities to the Anderson orthogonality catastrophe for static impurities. By operator reordering of the underlying many-body Hamiltonian, we obtain a modified fermionic dispersion relation that features a recoil-induced energy gap, which we call the “mass gap.” We show that the resulting mean-field Hamiltonian exhibits an in-gap state for finite impurity mass, which takes a key role in Fermi polaron and molecule formation. We identify the mass gap as the microscopic origin of the quasiparticle weight of Fermi polarons and derive a power-law scaling of the weight with the impurity-to-fermion mass ratio. The associated in-gap state is shown to give rise to the emergence of the polaron-to-molecule transition away from the limiting case of the Anderson orthogonality catastrophe in which the transition is absent. I will then present further extensions to the theory that allows to describe Fermi polaron formation at arbitrary mass imbalance beyond state-of-the-art precision.