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Optical signatures of charge ordering: from charge density waves to ordered polarons

As opposed to conventional charge density waves, that are well understood in terms of lattice-driven instabilities of the Fermi surface in metallic systems, there is no unified description of the charge ordering transitions observed in strongly interacting systems. Typical examples are found in transition-metal oxides (manganites, nickelates, cobaltates, vanadates, "telephone-number" ladder compounds) as well as in two-dimensional organic salts. Such systems are invariably characterized by a complex interplay between several microscopic interactions, involving the charge, spin, orbital and lattice degrees of freedom. While this complexity precludes the identification of a common charge ordering mechanism, it can be observed that electron-phonon interactions are always present in these systems to some extent, and often play a dominant role in driving the CO transition.

In this talk I will focus mainly on electron-phonon interactions, analyzing a prototypical model that allows to span continuously from the conventional charge density waves obtained in the weak coupling limit, to the polaronic ordered phases characteristic of the strong coupling limit. Two fundamentally different mechanisms of charge ordering can be identified in these two limits, which are directly reflected in the optical response of the system. In the strong coupling regime, the optical spectral weight exhibits an anomalous evolution with temperature, which can be taken as a distinctive experimental signature of polaronic charge ordering.

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