Correlations and charge ordering in quasi-one dimensional organic conductors

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Molecular conductors of the charge-transfer salt variety were designed with the intent that the electronic properties be tunable at the molecular level. The possibilities o ered by organic chemistry promised control of the properties of the solid state, with a principle goal being the advancement of high-temperature superconductivity. Regarding this quest, and otherwise predicting structure-property relationships, the strategy was a failure. Instead, electronic correlations induce a diverse set of ground states, and the competing interactions influence the higher-symmetry phases. Once the correlations were appreciated, some success in describing the physical properties followed. For example, the sequence of ground states observed for salts based on the TMTTF donor molecule, including non-magnetic insulating, spin-density wave, and superconducting phases was described. As well, the unusual frequency dependent conductivity seen at higher temperatures is a manifestation of the Tomonaga-Luttinger Liquid in a quasi-one dimensional crystalline system.

Several experimental techniques have proven invaluable for elucidating the interesting physics of organic conductors. NMR, through the hyperfine coupling is the only tool providing information about local magnetic fields, including spin density variations and spin dynamics. The recent discovery of charge ordered (CO) phases in the TMTTF class of conductors is an example of the utility of NMR. By now, it is realized that CO states are a phenomenon ubiquitous to insulating organic conductors. The CO state appears to be driven by longer range Coulomb correlations than previously thought important, and it is natural to ask its influence on the various ground states. ^{13}C NMR spectra, in the salts consisting of the centrosymmetric counterions AsF_6, SbF_6, and PF_6, demonstrate that a continuous charge-ordering transition leads to two inequivalent donor molecules where there was only one at higher temperatures. The absence for any magnetic anomaly indicates that the transition involves primarily the charge degrees of freedom, and ^{75}As, ^{121}Sb NMR spectra are consistent with weak coupling to the lattice. Models incorporating next-nearest neighbor Coulomb repulsion account for the observations .

As a result of the discovery of CO states, there is a renewed interest in understanding the insulators and an alternative mechanism for superconductivity has been predicted.