Conduction electrons in conventional and in strange metals: Fermi liquids and non-Fermi liquids

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Fermi liquids are interacting fermion systems whose elementary excitations and low temperature properties resemble those of a non-interacting Fermi gas. In particular, the conduction electrons in conventional metals form a Fermi liquid, and many metallic properties can be understood in terms of a simple Fermi gas model, as is frequently done in solid state physics courses. The at first sight surprising immunity of Fermi liquids to interactions is due to Pauli's exclusion principle, which follows from the fermionic statistics. Fermi liquid theory has been developed by Lev Landau already in the 1950s, but it was formulated on mathematically rigorous grounds only in the 1990s.

However, several important metallic compounds are "strange metals", which cannot be described by the Fermi liquid paradigm. Prominent examples are some layered cuprates which exhibit not only high temperature superconductivity, but unconventional metallic behavior also in a metallic phase above the critical temperature. Metallic interacting fermion systems which deviate from the Fermi liquid paradigm are collectively called "non-Fermi liquids". A breakdown of Fermi liquid behavior occurs generally in one-dimensional systems, or in the presence of singular effective interactions due to quantum critical fluctuations in the vicinity of quantum phase transitions. I will review basic concepts of Fermi liquid theory and present some examples of non-Fermi liquids.