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A Hund's rule mechanism for Hidden Spin-Orbital Density Wave in URu_2Si_2[1]

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It is proposed that the "Hidden Order" state of URu_2Si_2 corresponds to a combined spin-orbital density wave state, which is stabilized by the inter-orbital Hund's rule coupling. The electronic system is described by the underscreened Anderson Lattice Model, in which there are two-fold degenerate f bands which hybridize with a single conduction band. In the normal state, the bands at the Fermi-energy have almost pure 5f orbital characters in accord with the results of first principles electronic structure calculations. The model Fermi-surface has heavy fermion sheets which exhibit interband nesting and intraband nesting with similar wave vectors. The spin-flip terms of the Hund's rule interaction and the interband nesting produces a second-order phase transition which partially gaps the Fermi-surface, and leads to a state with broken spin-rotational invariance without forming a net ordered magnetic moment. The resulting spin nematic phase is consistent with the magnetic torque experiments of Okazaki *et al.*. The similarity of the interband nesting and the intraband nesting conditions leads to an adiabatic continuity between the "Hidden Order" and Antiferromagnetic phases for small values of the hybridization. The presence of a nearby hybridization gap results in an asymmetric form of the pseudogap caused by the "Hidden Order" transition. Precursor fluctuations of the hidden order parameter, above T_{HO}, lead to the formation of "hot spots" on the Fermi-surface and a depletion of the density of states in the vicinity of the Fermi-energy as is seen by point contact and optical spectroscopies. The amplitude of the precursor fluctuations increase as T_{HO} is driven towards zero, however, the order of the transition switches from second-order to first-order pre-empting the quantum critical point. These results in accord with the change in the order of the transition inferred by Jaime *et al.* from measurements of the specific heat in an applied magnetic field. This model might also be applicable to the enigmatic pseudo-gap phases seen in high-temperature superconductors.

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