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The hidden order phase in URu_2Si_2: Remarkable nesting and spin-orbital hybridization

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Aspects of Fermi surface (FS) nesting properties of URu_2Si_2 are analyzed with particular focus on their implication for the mysterious hidden order phase which occurs at 17.5 K. We show that there exist two Fermi surfaces that exhibit unusually strong nesting at the antiferromagnetic wavevector, $\mathbf{Q_0}=(0,0,1)$. The corresponding energy dispersions fulfill the relation $\epsilon_1(\mathbf{k})=-\epsilon_2(\mathbf{k}\pm\mathbf{Q_0})$ at eight FS hotspot lines on the surfaces. Notably, the spin-orbital characters of the involved $5f$ states are *different*: $j_z=\pm 5/2$ *vs.* $\pm 3/2$, and hence the occurring degenerate Dirac crossings are symmetry protected in the nonmagnetic normal state. Pairing of electrons in these two FSs can commence through interaction with a quasiparticle with wavevector $\mathbf{Q_0}$ and exchange of longitudinal angular momentum Δj_z. Dynamical symmetry breaking through an Ising-like spin-orbital excitation mode at $\mathbf{Q_0}$ with $\Delta j_z=\pm 1$ induces a hybridization of the two states, causing substantial FS gapping. Concomitant spin and orbital currents in the uranium planes can give rise to a rotational symmetry breaking. The existence of such specifically nested FSs in URu_2Si_2 is confirmed in recent experiments.

This work has been performed with S. Elgazzar, J. Rusz, Q. Feng, T. Durakiewicz and J.A. Mydosh.