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Hidden order in URu2Si2

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Complex electronic matter exhibit subtle forms of self organization which are almost invisible to the available experimental tools, but which have dramatic physical consequences. One prominent example is provided by the actinide based heavy fermion material URu_2Si_2. At high temperature, the U-5f electrons in URu_2Si_2 carry a very large entropy. This entropy is released at 17.5K via a second order phase transition to a state which remains shrouded in mystery, and which was termed a "hidden order" state. We developed a first principles theoretical method to analyze the electronic spectrum of correlated materials as a function of the position inside the unit cell of the crystal, and we used it to identify the low energy excitations of the URu_2Si_2 and to identify the possible candidate for the order parameter of the hidden order state. The first principles calculation for URu_2Si_2 show that U-5f electrons undergo a multichannel Kondo effect below 70K, which is arrested at lower temperature (35K) by the crystal field splitting. At even lower temperatures, two broken symmetry states can be stabilized, characterized by a complex order parameter *psi*. A real *psi* describes the hidden order phase, and an imaginary *psi* corresponds to the large moment antiferromagnetic phase, thus providing a unified picture of the two broken symmetry phases, which are realized in this material.