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Staggered spin-orbit coupling induced hidden order state in heavy-fermion metal URu2Si2 TANMOY DAS, LANL — The order parameter responsible for a second-order phase transition in the heavy fermion metal URu2Si2 at T = 17.5 K has remained a long-standing mystery. Here we show via ab-initio calculations that an incommensurate Fermi surface "nesting" in the partially-filled f-states causes a staggered spin-orbit coupling in the hidden-order state. In this cause neither the spin (S) nor the orbital (L) alone causes ordered state, rather a modulated spin-momentum locked density wave propagates along the unidirectional nesting direction with a polarized total angular momentum $m_J = \pm 2$, in excellent agreement with experiments. It breaks spontaneous rotational symmetry, but not the time-reversal symmetry and thus gives rise to the recently observed "nematic order" in this state. The hidden order state will be immune to any time-reversal invariant perturbation such as pressure, whereas magnetic field will destroy it. Remarkably, these are the hallmark properties of the hidden order state. We also compute the topological quantum number to show that the hidden-order gap opening can causes a trivial to non-trivial topological phase transition, and hence defines a novel "topological quantum critical point." Work is supported by US DOE.

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