The relation between "hidden order" and antiferromagnetism in $URu_{2-x}Fe_xSi_2$

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$URu_{2-x}Fe_xSi_2$ is a heavy fermion metal, where several electronic phases compete as the iron concentration is varied. At low temperature the material hosts two staggered phases, *i.e.*, a non-magnetic "hidden order" (HO) phase in the pristine compound, which at critical iron concentration, $x_c \approx 0.1$, acquires a local magnetic moment and transforms into a large moment antiferromagnetic (LMAF) phase. Below 1.5 K, a superconducting state, which likely breaks time reversal symmetry, emerges uniquely only within the HO phase. Here, we present polarized Raman scattering studies of the low-energy excitations out of the HO and LMAF ground states. All spectra show an in-gap collective mode in the pseudovector-like A_{2g} symmetry channel, which is antisymmetric under all reflections of the square lattice. In the HO phase, the mode energy decreases with iron substitution, disappearing at the critical iron concentration. In the LMAF phase, a collective mode again emerges in the A_{2g} symmetry channel, and its energy increases with increasing doping. We interpret these collective excitations as photo-induced transitions between the two competing electronic phases, both arising from the orbital degree of freedom of the 5*f* electrons condensates.

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