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Pairing symmetry in strongly hole-doped iron-based superconductors

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The fabric of superconductivity in the multiband iron-based superconductors is woven out of inter-band and intra-band interactions. By tuning the relative strength of different pairing interactions via external parameters such as pressure we can tune the pairing symmetry of these multiband superconductors. I will present experimental evidence for a pressure induced change of pairing state in the fully hole-doped iron-based superconductor KFe2As2. Our main experimental finding is a sharp reversal in the pressure dependence of Tc at a critical pressure Pc = 18 kbar [1]. Compared to previous reports on two separate superconducting domes in fully electron-doped chalcogenides, our discovery points to several novel aspects: (a) Pc is very low, meaning structural changes are negligible; (b) Tc remains finite through the transition, suggesting the phase transition is confined within the superconducting state; (c) No anomalies are observed in the normal state properties, ruling out the possibility of a Lifshitz transition; (d) The two superconducting states manifest a different sensitivity to disorder. These observations lead us to conclude that the sharp reversal of Tc at the critical pressure signals a phase transition between two different pairing symmetries in KFe2As2: a transition which leaves no traces in the normal state properties. Theoretical calculations formulate such a phase transition between different pairing states favored by different inelastic scattering processes [2]. We explore this hypothesis by tracing Tc versus inelastic scattering and demonstrate that below the critical pressure, Tc correlates with inelastic scattering but above the critical pressure, Tc anticorrelates with inelastic scattering. This is consistent with different channels of interactions giving rise to different pairing symmetries and pressure simply tunes the relative strength of these interactions.

[1] F. F. Tafti *et al.*, Nature Physics **9**, 349 (2013).
[2] R. M. Fernandes and A. J. Millis, Physical Review Letters **110**, 117004 (2013).