

Multiple Superconducting Phases in Tetragonal FeSe_{1-x}S_x

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The isovalently substituted FeSe_{1-x}S_x superconductors have attracted significant interest due to various exotic properties associated with the intertwining of nematicity, magnetism, and unconventional superconductivity [1]. Of particular interest is the abrupt change in the superconducting gap function that occurs at the nematic critical point at $x_c \sim 0.17$ [2-6], above which the formation of an ultra-nodal pairing state with a putative Bogoliubov Fermi surface has been proposed [5-10]. Although the emergence of the Bogoliubov Fermi surface appears to reasonably explain the huge residual density of states observed in the tetragonal FeSe_{1-x}S_x, the nature of the exotic pairing state remains largely elusive, including the links between the ultra-nodal state and the colossal fluctuation-like behavior reported in the previous experiments [11]. Here, using the high-quality single crystals of FeSe_{1-x}S_x and the precise measurements of thermodynamic and charge transport properties, we discuss the multiple superconducting phases associated with broken time-reversal symmetry, which suggests the frustrated pairing state with arbitrary phase shift. The results provide fresh insights into our understanding of the ultra-nodal pairing state.

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