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f-electron mediated Cooper Pairing in $CeCoIn_5$[1]

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Recent experimental breakthroughs in scanning tunneling spectroscopy have made it possible to probe how the complex electronic structure of the heavy fermion compound $CeCoIn_5$ evolves with decreasing temperature, eventually leading to the emergence of an unconventional superconducting state [1,2]. Using a recently developed theoretical model for quasi-particle interference (QPI) spectroscopy in heavy fermion materials [3,4], we demonstrate that the experimental QPI data are consistent with a superconducting order parameter of $d_{x^2y^2}$-symmetry, possessing a complex, multi-band momentum space structure [1]. Furthermore, we show that the unprecedented insight into the complex electronic structure of $CeCoIn_5$ above T_c opens a new path for identifying quantitatively the superconducting pairing potential, arising from the strong antiferromagnetic correlations in the heavy f-band [5]. Using this pairing potential to solve the multi-band superconducting gap equations provides us with a series of quantitative predictions for the critical temperature, the momentum space structure of the superconducting gaps, the phase sensitive QPI signature of the $d_{x^2y^2}$ pairing symmetry, the spin-lattice relaxation rate, and the form of the magnetic "spinresonance." The quantitative agreement between these predictions and the measured properties of superconducting $CeCoIn_5$ provides strong evidence for Cooper pairing being mediated by f-electron magnetism.

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