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Andreev reflection in heavy fermions and the superconducting order parameter in $CeCoIn_5$[1]

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Andreev reflection, a retro-reflection of an incoming electron as a hole at a normal-metal/superconductor interface, is well understood in conventional superconductors. For heavy-fermion superconductors, the microscopic consequences of the heavy electronic mass remain an open question. According to the Blonder-Tinkham-Klapwijk (BTK) theory, no Andreev process is allowed because of the large mismatch in the Fermi velocities [1]. However, conductance enhancement due to Andreev reflection, albeit reduced, has been frequently observed in heavy-fermion superconductors [2]. In this talk, I will present such conductance spectra obtained along three different crystallographic orientations of the heavy-fermion superconductor $CeCoIn_5$ [3]. Qualitative analysis using the extended BTK model shows the first spectroscopic evidence for $d_{x^2-y^2}$-wave (instead of d_{xy}-wave) symmetry, resolving the controversy over the node locations. In order to explain the reduced Andreev signal and the conductance asymmetry, both commonly observed in heavy-fermion superconductors, we propose a conductance model based on the two-fluid phenomenology [4] and an assumed energy-dependent density of states. I will discuss the significance of this model and possible clues for developing it into a microscopic theory. [1] G. E. Blonder, M. Tinkham, and T. M. Klapwijk, Phys. Rev. B **25**, 4515 (1982); G. E. Blonder and M. Tinkham, *ibid.* **27**, 112 (1983). [2] Yu. G. Naidyuk and I. K. Yanson, J. Phys.: Condens. Matter **10**, 8905 (1998). [3] W. K. Park *et al.*, arXiv:0709.1246 (submitted to Phys. Rev. Lett.). [4] S. Nakatsuji, D. Pines, and Z. Fisk, Phys. Rev. Lett. **92**, 016401 (2004). This work is done in collaboration with L. H. Greene, H. Stalzer, J. L. Sarrao, J. D. Thompson, Z. Fisk, and P. Canfield.

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