MAR09-2008-005123

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

Coexistence of two order parameters and a pseudogap in the iron-based superconductors[1]

RENATO GONNELLI, Dipartimento di Fisica and CNISM, Politecnico di Torino, Italy

The number, the symmetry and the amplitude of the order parameters (OPs) in the Fe-As superconductors are still open issues, as well as the origin of the electron pairing. To address these issues, we performed point-contact Andreev- reflection measurements in $SmFeAsO_{0.8}F_{0.2}$ (T_c^{on} = 53 K) and $LaFeAsO_{0.9}F_{0.1}$ (T_c^{on} = 27 K) polycrystals. In both cases, the low-temperature conductance curves clearly indicate the presence of two OPs in the superconducting state. No zero-bias peaks were observed, which – considering the non-directional current injection – clearly rules out the *d*-wave symmetry. If a superconducting character is supposed for both the OPs, their amplitudes can be extracted from a generalized two-band BTK fit (with two s-wave gaps, as in MgB_2) of the normalized conductance curves. The fit is indeed very good and gives OP amplitudes, Δ_1 and Δ_2, that lie slightly below and well above the BCS value, respectively. In Sm-1111, their low-temperature values are $\Delta_1(0) = 6.15 \pm 0.50$ meV and $\Delta_2(0) = 18 \pm 3$ meV, which give gap ratios ($2\Delta/k_BT_c$) of about 2.7 and 8.0. Both Δ_1 and Δ_2 show a BCS-like temperature dependence and close at the bulk T_c. In La-1111 we obtained point contacts with different local T_c (from 27.3 to 31.0 K) in crystallites with slightly different doping. Here Δ_1 shows a non-BCS temperature dependence with a high- temperature "tail," while Δ_2 seems to close at $T < T_c$. While the low-temperature gap $\Delta_1(0)$ increases on increasing T_c (remaining always around the BCS value), $\Delta_2(0)$ decreases and finally disappears when $T_c = 31$ K, reminding the case of cuprates. At T_c, the normal-state conductance is asymmetric and shows features at zero bias (a depression or pseudogap in La-1111, a hump in Sm-1111) that however are also present in the superconducting state and are progressively washed out on increasing temperature, to finally disappear at $T^* \simeq 140$ K, close to the Néel temperature of the parent compound.

[1]Co-authors: D. Daghero, M. Tortello, G.A. Ummarino, V.A. Stepanov, J.S. Kim, R.K. Kremer, J. Karpinski, N.D. Zhigadlo.