Spin-resolved crossed Andreev reflection

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We analyze non-local effects in electron transport across three-terminal normal-superconducting-normal (NSN) structures where normal electrodes can be non-magnetic metals, ferromagnets or half-metals [1-3]. Subgap electrons entering S-electrode from one N-metal may form Cooper pairs with their counterparts penetrating from another N-metal. This phenomenon of crossed Andreev reflection (CAR) – combined with normal scattering at SN interfaces –yields two different contributions to non-local conductance which we evaluate non-perturbatively at arbitrary interface transmissions and their spin polarizations. Our theory fully describes non-trivial interplay between spin-sensitive normal scattering, local and non-local Andreev reflection at SN interfaces and provides a quantitative explanation for a number of recent experimental observations, such as, e.g., the so-called charge imbalance peak in non-local resistance [4,5]. One of the most striking predictions of our theory is the total suppression of CAR at full interface transmissions. We also demonstrate that CAR is highly sensitive to electron spins yielding a rich variety of interesting properties which can be directly tested in future experiments on multi-terminal hybrid structures with ferromagnetic and half-metallic electrodes.

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