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Effect of Intra-Dot Coulomb Interaction on Andreev Reflection in Normal-Metal/Quantum-Dot/Superconductor System

ZHU Yu, SUN Qing-Feng and LIN Tsung-Han

State Key Laboratory for Mesoscopic Physics and Department of Physics, Peking University, Beijing 100871, China
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Abstract: We investigate the effect of intra-dot Coulomb interaction on the Andreev reflection in a normal-metal/quantum-dot/superconductor (N-QD-S) system with multiple levels in the quantum dot, in the regime where the intra-dot interacting constant is comparable to the energy gap of superconducting lead. By using nonequilibrium Green function method, the averaged occupation of electrons in the quantum dot and the Andreev reflection (AR) current are studied. Comparing to the case of non-interacting quantum dot, the system shows significant changes for the averaged occupation of electrons in QD ($\langle n \rangle$) and the AR current (I). (i) In the linear response regime, $\langle n \rangle$ -V_g exhibits a two-step-like behavior; and the I-V_g shows two groups of peaks, separated by U and with equal heights, where V_g is the gate voltage and U denotes the intra-dot Coulomb interaction constant. (ii) For finite bias voltage, dips, superposed on the step-like $\langle n \rangle$ -V_g curve, and the current peaks appear simultaneously, both originate from the AR processes. For $V \geqslant U/2$, extra AR current peaks occur between the two groups of the peaks. Besides, the properties of the heights of the AR current peaks are more complicated.

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Key words: Coulomb interactions, Andreev reflection, normal-metal/quantum-dot/superconductor system

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