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H. Ahmad - Electrodynamics of Highly Spin-Polarized Tunnel Josephson Junctions

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The continuous development of superconducting electronics is encouraging several studies on hybrid Josephson Junctions (JJs), such as SFS heterostructures. The competition between the superconducting order parameter in the electrodes and the ferromagnetic order parameter in the barrier leads to unconventional properties like: second harmonics in the current-phase relation (CPR), a transition in the phase difference between the electrodes from 0 to π and the formation of spin-triplet Cooper pairs currents, exploitable in spintronic devices and switchable elements in quantum/classical circuits. However, most of the applications of SFS JJs in real superconducting circuits are limited by the high decoherence in these devices due to quasiparticles poisoning. We propose here an electrodynamic characterization of a new kind of ferromagnetic JJs in which the barrier is an insulating ferromagnet (tunnel-ferromagnetic spin-filter JJs). Spin-filter JJs show evidences of MQT and an incomplete 0-π transition that could enhance the capabilities of SFS JJs also as active elements. In order to meet specific circuit requirements it is necessary a full comprehension of the dissipation processes and the knowledge of the scaling laws with the thickness of fundamental electrodynamics parameters, like the resistance due to the quasiparticles and the capacitance of the device. We show that the Tunnel Junction Microscopic (TJM) model leads to a reliable and self-consistent estimation of these parameters, and that our self-consistent approach can be fully extended to other type of tunnel JJs.