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Modeling Excess Current in Josephson I-V Characteristics[1]
BJORN WEHLIN, ETHAN CHO, MENG MA, SHANE CYBART, ROBERT DYNES, Univ of California - San Diego — The current-voltage characteristics (I-V) of some metal-barrier Josephson junctions include a current component that does not exhibit the DC, or AC Josephson effects. This current is referred to as the excess current, I_χ. Moreover, while I_χ is negligible around the transition temperature T_C, it increases and can exceed 50% of the total current as temperature is decreased. Normally, I_χ is omitted from Josephson I-V models and this leads to a large overestimate of the product of Josephson critical current, I_C, and normal-state resistance, R_N (i.e., $I_C R_N$). We have developed an extended I-V model based on the Stewart-McCumber and Ambegaokar-Halperin models that includes I_χ. Using our model, we fit experimental I-V data for planar Y-Ba-Cu-O junctions over a range of temperatures. From these fits we obtain values for I_χ, I_C and R_N, as well as noise temperature. Our values agree well with experimental measurements. I_C is suppressed using a magnetic field. Further, our I_C exhibits an asymptotic temperature dependence like that expected for a superconducting energy gap well below T_C. Our model is an improvement over existing models as it reliably estimates $I_C R_N$.

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