Quantum Nucleation of Josephson Vortices in Superconducting Grain Boundary Junctions

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We report on new developments in the theory of time-correlated soliton tunneling,* applying the model to quantum nucleation of Josephson vortex-antivortex pairs in high-temperature superconducting (HTS) grain boundary junctions. A magnetic dual of the Coulomb blockade mechanism leads to a sharply defined critical current for vortex pair nucleation. The model shows excellent agreement with a wide range of measured voltage-current characteristics of grain boundary junctions in HTS thin films. Moreover, by hypothesizing that the critical current of HTS coated conductors is limited by natural low-angle grain boundaries, the observed unusual critical current vs. thickness dependence and the mechanism for its improvement via multiple layers emerges naturally. Finally, when applied to charge density wave (CDW) systems, simulations of the the time-correlated soliton tunneling model show excellent agreement with experimentally measured CDW current-voltage characteristics and coherent voltage oscillations.

*J. H. Miller, Jr., et al., Phys. Rev. Lett. **84**, 1555 (2000).