The Fluctuations of the Phase Difference Across An Array of Josephson Junction

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We present calculations of the thermodynamic fluctuations of the phase difference Δ across an array of Josephson junctions in superfluid ^{4}He. We use a model of the Josephson effect, analogous to a rigid pendulum, to understand the dynamics of Δ in the limit of large fluctuations. In this model, the angle sustained by the pendulum is analogous to Δ. We show that the rms fluctuations of Δ increase as the lambda transition is approached. At a critical value of Δ, the fluctuations of Δ can exceed 2π causing a continuous phase slip. The probability of a phase slip increases closer to the lambda point until $\Delta(t)$ becomes chaotic and the Josephson effect disappears. We show that the mean square fluctuations of Δ decrease ~ 1/N, where N is the number of orifices in the array. We show that for a single junction of dimension LxLxL, near the lambda transition where the correlation length is ~L, there is already a significant probability of phase slip. This means that the Josephson effect does not occur in a single junction but does occur in an array of such junctions.