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Fluxon Dynamics in a Long Josephson Junction

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Abstract: A long Josephson junction consists of two superconducting layers, separated by a thin insulating layer. The important physical quantity is the difference between the phase of the electrons in the two layers. This phase difference is described by a perturbed sine-Gordon equation. Waves, called *fluxons* in the physics literature, travel in the junction when an external current is applied. Existence of these fluxons can be analyzed analytically for small applied bias currents. The fate of the fluxons for larger currents can be studied numerically.

We determine the linearised stability of the fluxons by calculating the Evans function. Surface resistance corresponds to a singular perturbation term in the governing equation, which specifically complicates the computation of the corresponding Evans function. Both the flow of quasi-particles across and along the junction stabilise the waves. The parameter values for which the fluxons exist appear to lie on a spiral. We show that this is a consequence of the presence of a heteroclinic solution, which lies at the centre of the spiral.

In high temperature superconductors there is the possibility for discontinuity points in the phase. We investigate analytically a long Josephson junction with one π-discontinuity point characterized by a jump of π in the phase difference of the junction. This system is described by a perturbed-combined sine-Gordon equation. Via phase-portrait analysis, it is shown how the existence of static semifluxons localized around the discontinuity point is influenced by the applied bias current. In junctions with more than one corner, there is a minimum-facet-length for semifluxons to be spontaneously generated.