Escape and Retrapping Experiments with Josephson φ Junctions

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Abstract — A ϕ Josephson junction (JJ) is a junction having a degenerate ground state phase ±ϕ (0 < ϕ < π) [1]. This results from a specific Josephson energy profile, which looks like a 2π-periodic double-well potential. Such ϕ JJs have unusual physical properties and attractive for applications such as phase batteries for classical and quantum digital circuits, memory or random number generators [2-9].

In my talk I will revisit the key properties of ϕ JJs that can be seen experimentally, e.g., two critical currents that can be used for detecting the internal state of the ϕ JJ [6]. Further I will present our recent experiments on phase escape and retrapping in different types of ϕ JJs.

By measuring the switching current histograms that, in general, exhibit two escape peaks corresponding to critical currents Ic+, we are able to calculate the probability of the phase to be trapped in -ϕ and +ϕ wells when the junction returns from non-zero- to zero-voltage-state. We show that, similar to the theoretical prediction [4], at high temperature the retrapping is deterministic (always in the +ϕ well), while at lower temperature we observe an onset of the butterfly effect with an oscillating probability of trapping in a particular well. Unexpectedly, the probability of trapping in a particular well saturates at a value different than 50% at low temperatures.


Keywords (Index Terms) — ϕ Josephson junction, butterfly effect, bi-stability, superconductor, ferromagnet