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 ($0 < \varphi < \pi$) [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.

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