Escape rate measurements of 0, π and 0-π ferromagnetic Josephson junctions

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Josephson junctions (JJ) with a ferromagnetic barrier can be used to realize π junctions, which have, in comparison to conventional 0 junctions, a phase drop of π in the ground state. By joining a 0 and π JJ, a 0-π JJ can be created with a novel groundstate: a semifluxon. A semifluxon is a vortex, which is formed spontaneously at the 0-π boundary. It carries the magnetic flux $\Phi = \pm\Phi_0/2$, where Φ_0 is the magnetic flux quantum. We have investigated the phase dynamics of underdamped 0, π and 0-π ferromagnetic Josephson tunnel junctions of intermediate length. The junctions have been fabricated as $Nb/Al_2O_3/Ni_{60}Cu_{40}/Nb$ superconductor-insulator-ferromagnet-superconductor heterostructures. We measured the switching current statistics down to 20 mK and as a function of an applied magnetic field. We analyzed our data in the framework of transition state theory[1] and found good agreement for both, the quantum tunneling and the thermal activation regime, with no indications of additional (spin) noise due to the ferromagnet.

[1]Hänggi *et al.*, Rev. Mod. Phys. **62**, 251 (1990).