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Interplay between the phase dynamics and edge states in Josephson junctions of time-reversal invariant topological superconductors

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Two-dimensional time-reversal invariant topological superconductors (TRITOPS) host a Kramers pair of propagating edge states. Their coupling in a Josephson junction can be described by a Dirac Hamiltonian with a mass term that depends on the phase bias of the junction. Notably, this mass term exhibits different characteristics in junctions between TRITOPS compared with those between a TRITOPS and a non-topological superconductor (S). In the latter case there is an instability towards a state with broken time-reversal symmetry.

In this talk, I will briefly outline how these properties lead to a markedly different behavior of the current-phase relation in each type of junction.
Additionally, I will discuss the stability of the broken-symmetry state of the TRITOPS-S junction against the phase fluctuations.

I will also discuss the effect of fluxons in the junction giving rise to the formation solitons in the phase field. These solitons induce a spatially varying mass for the edge modes, akin to the Jackiw-Rebbi model. Consequently, topological fermionic modes emerge localized at the fluxons.
The nature of these modes also depends on the type of junction, being single Majorana fermions in the TRITOPS-S case. Lastly, I will analyze the impact of these localized modes on the dynamics of soliton-antisoliton collisions.

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