Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Josephson current in finite-lenght nanowire SNS junctions with Majorana fermions RAMON AGUADO, ELSA PRADA, ICMM-CSIC, Consejo Superior de Investigaciones Científicas, PABLO SAN JOSE, IEM-CSIC, Consejo Superior de Investigaciones Científicas
— The dc Josephson effect (JE) through infinite-lenght junctions of one-dimensional topological superconductors exhibits an anomalous 4π periodic phase (ϕ) dependence which originates from a parity-protected level crossing of zero-energy Majorana bound states (MBS) at $\phi = \pi$. This "fractional" JE provides an important experimental detection tool for MBS. In this talk, I will discuss the JE in more realistic SNS junctions of arbitrary transparency and when both the normal and the nanowire regions are of finite length, namely beyond the short-junction and infinite topological superconductor limits. In general, the spectrum of Andreev bound states can become rather intricate and dense as opposed to the infinite-lenght case. Moreover, the low-energy spectrum around $\phi = \pi$ shows always anticrossings, originated from hybridization of four MBS, which may preclude the experimental observation of the fractional JE. At finite bias voltages, Landau-Zener dynamics involving the MBS and quasi-continuum Andreev levels gives rise to a nontrivial ac Josephson current. Interestingly, the ac current phase diagram as a function of the Josephson frequency/normal transmission shows fractional JE regions which are tunable through bias/gate voltages.

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Date submitted: 07 Dec 2011 Electronic form version 1.4