Topological phase enhancement in planar Josephson junction in the long junction regime

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Planar Josephson junctions are considered promising devices for the realization of Majorana bound states (MBS) thanks to the possibility of controlling the topological transition by superconducting phase difference [1]. The topological transition occurs even at small magnetic fields, but typically the phase range with the topological superconductivity is small and cannot be probed directly when the superconducting phase difference is implied by the external magnetic flux [2]. Here, we theoretically show that the topological phase region can be significantly extended by elongating the junction, which leads to the amplification of the Zeeman effect. We point out that the decrease in the induced gap in long junctions, due to transverse modes with high momenta parallel to the superconducting interfaces that can lead to the destruction of MBS [3], can be overcome by the introduction of additional superconducting contacts that further proximitize the semiconductor region and reopen the superconducting gap. We show that in the proposed system, the topological transition can be probed by critical current measurements.

References

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Figures

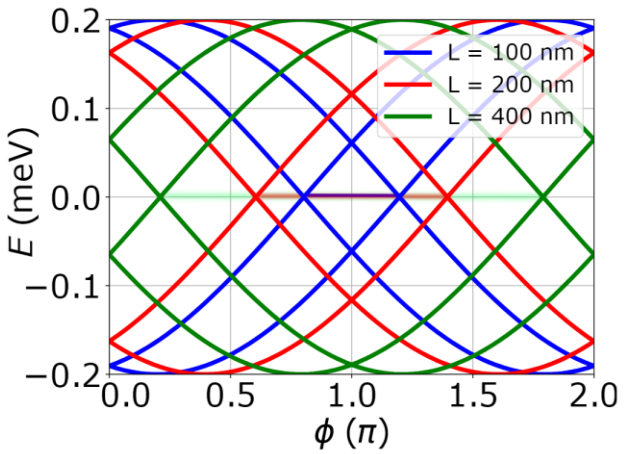

Figure 1 Schematic of an energy-phase relation of a Josephson junction. Three lines at zero energy, depicted in blue, red, and green, denote the region where Majorana bound states appear for three different junction lengths.