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Josephson currents in semiconductor nanowire / s-wave superconductor nanostructures LI MAO, Department of Physics, the University of Texas at Dallas, Richardson, TX, 75080 USA, SUMANTA TEWARI, Department of Physics and Astronomy, Clemson University, Clemson, SC, 29634 USA, CHUAN-WEI ZHANG, Department of Physics, the University of Texas at Dallas, Richardson, TX, 75080 USA — It has been theoretically predicted that a nanostructure composing of a semiconductor nanowire with strong spin-orbit coupling and an s-wave superconductor can support two Majorana fermions at the ends of the nanowire in the presence of a Zeeman field. Recently, following the theoretical proposals, some preliminary experimental signatures (e.g., zero-bias conductance peak) which may be related to the existence of Majorana fermions have been observed in the charge transport experiments. Here we investigate the Josephson currents with the zero-bias voltage in the topologically trivial region of a superconductor-insulator-superconductor junction in the presence of strong spin-orbit coupling and Zeeman field. This structure may be relevant to the Delft experiment by considering the possible proximity effect of the superconductor lead to the normal part of the nanowire. Our results indicate that the experimentally observed zero-bias conductance peak may not originate from Majorana fermions.

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