Properties of Hetero-structures involving Superconducting and Semiconducting Elements with Strong Spin-Orbit Coupling

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Recently there has been a general excitement in the condensed matter community following the predictions that hetero-structures composed of relatively conventional materials, i.e. conventional superconductors and semiconductors with strong spin-orbit coupling, could exhibit so called Majorana Fermions and associated non-Abelian statistics[1][2] - properties which were initially predicted in far more exotic states of matter such as the p+ip superconductors and the fractional quantum Hall state. While the initial proposals were based on a phenomenological low energy theory of the heterostructure region, several microscopic approaches including tunnel model and tight binding calculations have been used to confirm some features of the low energy theory. Here we present a more complete description of the system using a wave-matching technique for the generalized BdG equation which clarifies the role of the microscopic processes (Andreev Reflections) and interface bound states (Andreev Bound States) in defining the low energy theory.

[1]J. D. Sau, R. M. Lutchyn, S. Tewari, and S. Das Sarma, *Phys. Rev. Lett.* **104**, 040502 (2010)
[2]J. Alicea, Y. Oreg, G. Refael, F. von Oppen, and M. P. A. Fisher, *Nature Physics* (2011), doi:10.1038/nphys1915