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Weak and strong coupling regimes in Majorana hybrid structures

JOHN STENGER, TUDOR STANESCU, West Virginia University — We study the proximity-induced low-energy physics that emerges in semiconductor - superconductor hybrid structures in the weak and strong coupling regimes. We find that the proximity-induced gap has a non-monotonic dependence on the effective semiconductor - superconductor coupling strength. To identify the qualitative difference between weak and strong coupled regimes characterized by similar values of the induced gap, we determine the dependence of the differential conductance of a metal - semiconductor - superconductor structure capable of hosting zero-energy Majorana bound states on the heterostructure parameters (semiconductor wire thickness, semiconductor - superconductor coupling strength, etc.) and on applied external fields. We show that an effective low-energy theory can be constructed by properly integrating out the high-energy degrees of freedom (rather than simply ignoring them), which results in a strong renormalization of the low-energy sector. Using this effective theory, we describe the qualitative differences between the Majorana signatures emerging in the weak and strong coupling regimes.

John Stenger
West Virginia University

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