Quantized Spin Pumping in Majorana Nanowires

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A well-established theoretical platform for hosting Majorana quasiparticles is a Rashba spin-orbit-coupled semiconductor with proximity induced superconductivity and subjected to an external magnetic field. The challenge today is not so much in engineering systems that could support Majoranas, but in conclusively detecting their presence. To address this, the authors of Ref. [1] proposed an alternative approach: they augment the conventional setup by adding a ferromagnetic insulator with a precessing magnetization. This dynamic magnetic environment induces a spin current in the semiconducting nanowire. Their numerical simulations for a single-subband nanowire reveal that in the topological (Majorana) phase, the pumped spin is quantized—a clear distinction from the trivial phase, where no such quantization occurs. We extend the calculations to multi-subband nanowires and once again observe robustly quantized spin pumping. However, this quantization is constrained to values of +1 or -1 in consecutive non-trivial regions of the phase diagram.

References

[1] V. Fernández Becerra, Mircea Trif, and Timo Hyart, Phys. Rev. Lett. 130, 237002 (2023)

Figures

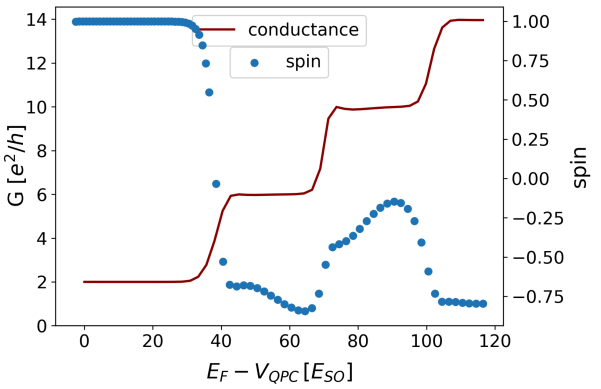

Figure 1: Spin and conductance calculations in the **non-trivial** regime of the nanowire.

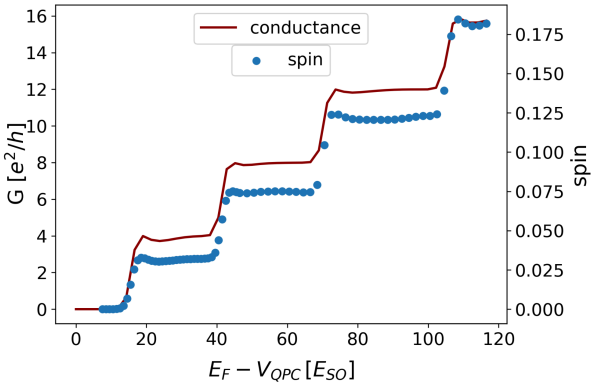

Figure 2: Spin and conductance calculations in the **trivial** regime of the nanowire.