Driven Topological Insulator Quantum Dot: A spin-particle source (SpPS)

Dario Bercioux, Andreas Inhofer

Donostia International Physics Center, Donostia-San Sebastian,Spain

dario_bercioux001@ehu.es

Abstract

We propose a device that allows for the emission of pairs of spin-polarized electrons into the edge states of a two-dimensional topological insulator [1]. Charge and spin emission is achieved using a periodically driven quantum dot weakly [2] coupled to the edge states of the host topological insulator. We present calculations of the emitted time-dependent charge and spin currents of such a dynamical scatterer using the Floquet scattering matrix approach. Experimental signatures of spin-polarized two-particle emission can be found in noise measurements [3,4]. Here we introduce a new form of noise suppression, named Z_2 anti-bunching. Additionally, we propose a setup in which entanglement of the emitted electrons is generated. This entanglement is based on a post-selection procedure and becomes manifest in a violation of a Clauser-Horne-Shimony-Holt inequality [3].

References

[1] M.Z.Hasan & C. L. Kane Rev. Mod. Phys. **82**, 3045 (2010).

[2] G.Fève et al. Science **316**, 1169 (2007)

[3] A. Inhofer & D. Bercioux, Phys. Rev. B **88**, 235412 (2013).

[4] P. Hofer & M. Büttiker, Phys. Rev. B **88**, 241308R (2013).

Figures

Zero-temperature emitted charge as a function of the height of the driving step U_0. The various lines correspond to different values of the reflection probability of the QPC $|\lambda_{pb}|^2$: $|\lambda_{pb}|^2$=0.95 (solid red line), $|\lambda_{pb}|^2$=0.5 (dashed blue line), and $|\lambda_{pb}|^2$=0.1 (dotted green line). Please note that the steps are given in units of twice the electron charge. Upper inset: The density of states of the QD for various values of $|\lambda_{pb}|$. Lower inset: Model of driving we consider: the driving of the gate is switched on at time t_0 and the potential is changed by a quantity U_0.