Effects of spin-orbit coupling on transport through a QPC modulated by a periodic potential

Sigurdur I. Erlingsson[1], and Gunnar Thorgilsson[1]

[1]*School of Science and Engineering*
Reykjavik University, Menntavegi 1, IS-101 Reykjavik
Iceland

The strength of the Rashba spin-orbit interaction can be measured via transport using different experimental setups [1], e.g. magnetoresistance measurements via Shubnikov-de Haas oscillations [2, 3], and weak anti-localization [5, 4]. Recently, it was proposed that the Rashba strength could be extracted from a charge conductance measurement of a parabolic quantum wire, with a quasi-periodic potential along the transport direction [6].

In this work we will expand on the proposal in [6]. By replacing the quantum wire with a quantum point contact (QPC), we are better able to address experimentally relevant systems. Starting from a 2DEG with Rasbha spin-orbit coupling we calculate charge transport through a QPC which in addition is modulated by a quasi-periodic potential, located in the constriction part of the QPC. The transport calculations are based on the recursive Green's function method. The quasi-periodic potential is chosen such that it will open up gaps in the density of states where the effect of the spin-orbit coupling is most prominent. This will lead to dips in the conductance through the system, and the position of the dips is determined by the strength of the Rashba coupling. Experimentally the quasi-periodic potential can be realized using finger gates [6]. The transport results are compared with energy spectra for the corresponding ideal periodic potential. The position of the dips match with the position of the gaps in the energy spectra. Thus, a relatively low number of finger gates, between 10-20 finger gates, can be sufficient to open up gaps.

Also, we will consider the case of a quasi-periodic magnetic field, induced by ferromagnetic finger gates. In this situation the dips will affect the two spin species differently, leading to spin polarized current through the QPC. We will study how different orientation of the magnetization of the finger gates affect the transport properties of the system.

[1] W. Zawadzki, and P. Pfeffer, Semicond. Sci. Tech. **19**, R1 (2004).
[2] J. Nitta, T. Akazaki, H. Takyanagi, and T. Enoki, Phys. Rev. Lett. **78**, 1335 (1997).
[3] G. Engels, J. Lange, T. Schäpers and H. Lüth, Phys. Rev. B **55**, R1958 (1997).
[4] T. Koga, J. Nitta, T. Akazaki, and H. Takyanagi, Phys. Rev. Lett. **89**, 046801 (2002).
[5] V.A. Guzenko, T. Schäpers, and H. Hardtdegen, Phys. Rev. B, **76**, 165301 (2007).
[6] G. Thorgilsson, J.C. Egues, D. Loss, and S.I. Erlingsson, Phys. Rev. B **85**, 045306 (2012).