Spin-orbit driven phenomena in Dirac fermions with Rashba spin-orbit interaction – transport characteristics at finite temperatures

A. Krzyżewska,¹ B. Spisak,² and A. Dyrdal¹

¹Department of Mesoscopic Physics, ISQI, Faculty of Physics, Adam Mickiewicz University, ul. Uniwersytetu Poznańskiego 2, 61-614 Poznań, Poland
²Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, al. Mickiewicza 30, 30-059 Kraków, Poland

Spin-orbit driven phenomena, such as the spin Hall effect or current-induced spin polarization, enable electrical control of the spin degree of freedom and efficient spin-to-charge interconversion. Using the Matsubara Green function’s formalism and the linear response theory, we considered the spin-orbit driven transport properties of Dirac fermions in the presence of weak Rashba spin-orbit interaction. Such a model may be used to describe transport properties of graphene and graphene-like 2D crystals beyond the zero-temperature limit. In the regime of weak Rashba coupling, we obtained analytical formulas describing the spin Hall effect and current-induced spin polarization and their thermal counterparts at arbitrary temperature. The considered model can be adapted easily to study many-body physics in Dirac-Rashba systems.

This work has been supported by the National Science Center in Poland (NCN) under the project No. DEC-2018/31/D/ST3/02351.