INTRINSIC SPIN HALL AND SPIN NERNST EFFECTS IN SINGLE-LAYER AND BILAYER GRAPHENE

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9.7 cm

We have considered theoretically the spin Hall and spin Nernst effects in single-layer and bilayer graphene. The relevant calculations take into account the intrinsic spin-orbit interaction. To describe electronic spectrum of both single-layer and bilayer graphene we have assumed some effective Hamiltonians which are sufficient when considering states near the Dirac points. We have also considered a more realistic electronic spectrum based on the relevant tight binding model. The corresponding contributions to both spin Hall and spin Nernst effects have been determined using the linear response theory and Green function formalism.

Our results show that the spin Hall conductivity of the bilayer graphene acquires universal and quantized values inside the energy gap, similarly as the single-layer graphene. However the spin Hall conductivity in the bilayer graphene is twice as large as that for the single-layer graphene. When the spin-orbit parameters in both atomic planes of bilayer graphene are different, the spin Hall conductivity as a function of the Fermi level is constant inside the energy gap and reveals a kink associated with the larger spin-orbit parameter. Additional peaks appear then at this point in the thermoelectric spin Nernst conductivity. We have also compared the results obtained from the effective Hamiltonians with those obtained in the tight binding model.

13.4 cm

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