Spin Conductance of Diffusive Graphene Nanoribbons

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We investigate spin transport in diffusive graphene nanoribbons with both clean zigzag and rough edges. Along the edges long range disorder causes the local doping to come close to the charge neutrality point at certain regions. In this work, we focus on a model where such regions have localized magnetic moments, similar to the well known magnetic edge of smooth zigzag graphene nanoribbons. This random edge magnetization can polarize charge currents and cause sample to sample fluctuations of the spin currents that follow universal predictions from the Dorokhov-Mello-Pereyra-Kumar equations (Fig. 1). In the present work, we show that although the average spin conductance G_S of these ribbons vanishes, an applied transverse in-plane electric field a finite average spin conductance can be observed (Fig. 2). Similar effect can also be achieved by aligning the edge magnetic moments e.g. by applying an external magnetic field.

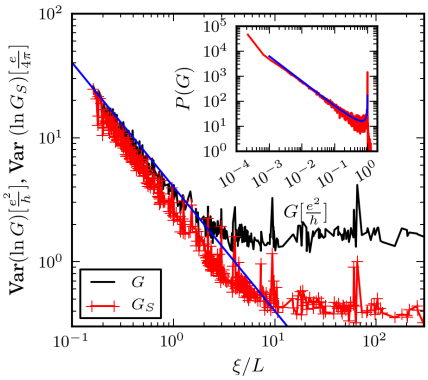

Fig. 1: Var [ln G] (black) and Var [ln G_S] (red) as a function of ξ / L for various ribbons of length L and localization length ξ. According to DMPK equations the eigenvalues of the conductance matrix exhibit a log-normal distribution with ⟨ln G⟩ = 2 Var [ln G] = L / 2 ξ (blue curve). While ⟨G_S⟩ = 0, also Var [ln G_S] is determined by the single parameter ξ / L.

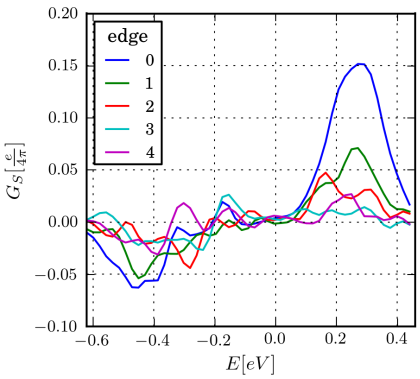

Fig. 2:Average spin transmission of nanoribbons under the influence of a transverse in-plane electric field. The potential difference leads to a maximum spin conductance at Fermi energies V_{dis}-t' and -V_{dis}, where t' is the next-nearest neighbor hopping The edge indices indicate the roughness fromx 0 for a perfectly clean zz edge, to 4 for an edge with approximately 8% defects.