Dynamical control of topological properties in 2D quantum matter

Jorge Martínez Romeral
Luis M. Canonico, Aron W.Cummings and Stephan Roche

Catalan Intitute of nanoscience and Nanotechnology (ICN2), UAB campus, Barcelona, Spain

jorge.martinez@icn2.cat

Topological properties have been extensively studied over the past decades [1]. However, their practical implementation remains challenging due to the need for extreme conditions, such as strong magnetic fields and low temperatures, as well as limitations in material availability and cost [2]. Light, on the other hand, has emerged as an effective tool for inducing topological phases in otherwise trivial materials. Although this phenomenon has been widely explored theoretically [3,4], experimental realizations remain scarce. This gap arises partly from the lack of theoretical studies computing observable properties and partly from the difficulty of performing such calculations under experimentally relevant conditions, including disorder and thermal relaxation. In this work, we introduce a new methodology based on quantum dynamics that allow us to compute out-of-equilibrium material properties, such as charge conductivity, in the presence of non-perturbative disorder and energy dissipation [4]. We demonstrate how otherwise trivial materials such as gapped dirac materials, for example hBN, can arrise topological properties, Figure 1. Furthermore we analyse these properties in the presence of realistic disorder conditions and energy dissipation rates.

References

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Figures

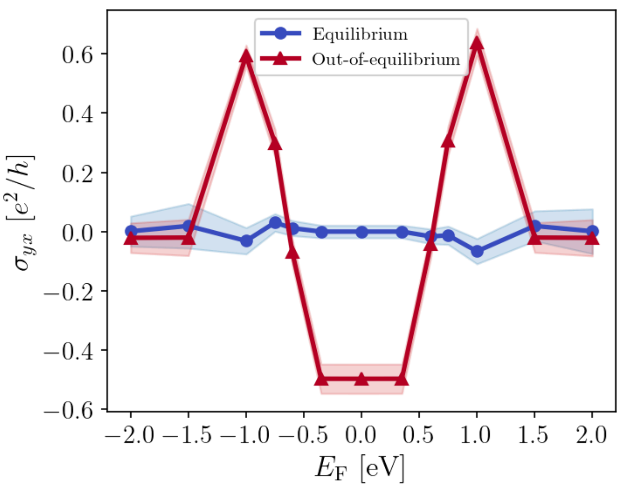

Figure 1: Equilibrium (blue) and out of equilibrium (red) Hall conductivity when shining gapped graphene with a pulse of circular polarized light.