# Nonlocal Signals of Orbital Angular Momentum Transport in Graphene

**L. M. Canonico**
M. Vila, T.G. Rappoport and Stephan Roche
*ICN2, Universitat Autònoma de Barcelona, Edifici ICN2 Campus de la, Av. de Serragalliners, s/n, 08193 Bellaterra, Barcelona, Spain.*
luis.canonico@icn2.cat

In the last decades, the development and the successes accumulated by the field of spintronics demonstrated that harnessing the quantum degrees of freedom of the matter is the most prominent pathway for further technological development. Following the lines set by spintronics, orbitronics explore the possibility of manipulating the orbital angular momentum of the carriers to store and process information using the orbital Hall effect as its main lever. In resemblance to the spin Hall effect, the orbital Hall effect refers to the appearance of a transverse orbital angular momentum current after applying a longitudinal electrical field [1].

Contributions for the orbital Hall effect are separated as intra- and inter-atomic contributions since they refer to the localized atomic and motion orbital angular momentum, respectively [2,3]. Despite being studied for 3D systems, recent works on 2D materials demonstrated that materials with vanishing spin Hall conductivity such as mono- [4] and bilayers [5] of transition metal dichalcogenides and gaped graphene monolayers [6] exhibit finite orbital Hall conductivity, which is given by intra- and interatomic contributions, respectively. Using the Landauer-Büttiker formalism, we show that gapped graphene devices present sizable non-local resistance signals related to conduction through dispersive edge states. Investigating the effect of weak magnetic fields on these non-local signals, we find that they exhibit a chiral behaviour with the field direction. Our results suggest that the origin of the non-local resistance signals in gapped graphene devices are described more transparently in terms of orbital angular momentum currents.

## References

[1] B. A. Bernevig, T. L. Hughes, and S.-C. Zhang, PRL, 95, (2005), 06660.
[2] Cysne, T. P., Bhowal, S., Vignale, G., & Rappoport, T. G. arXiv preprint arXiv:2201.03491 (2022).
[3] Pezo, A., Ovalle, D. G., & Manchon, A. arXiv preprint arXiv:2201.05807 (2022).
[4] Canonico, L. M., et al. PRB (R) 101 (2020) 161409.
[5] Cysne, T. P., Costa, M., Canonico, L. M., Nardelli, M. B., Muniz, R. B., & Rappoport, T. G. PRL, 126(5), 056601 (2021).
[6] Bhowal, S., & Vignale, G. Physical Review B, 103(19), 195309 (2021).

## Figures

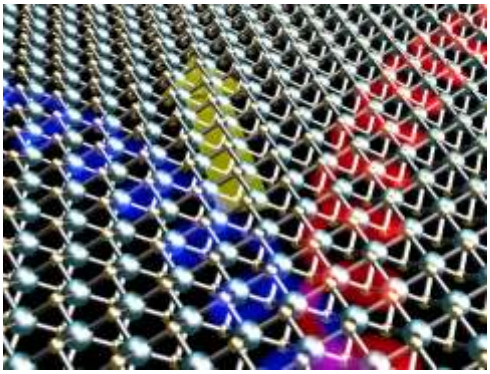

**Figure 1:** Schematic representation of the orbital-Hall effect.