Orbital Hall effect in two-dimensional materials

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Orbitronics, a next-generation technology utilizing orbital angular degrees of freedom, has gained renewed interest for its potential use in logic and memory devices. By harnessing the orbital angular momentum as an information carrier, this technology has the potential to revolutionize the field of information processing.

In this talk will explore orbital effects in solids and their potential implications. I will concentrate on the orbital-Hall effect (OHE), which is similar to the spin-Hall effect (SHE) in that it creates a transverse flow of angular momentum due to a longitudinally applied electric field. However, it emerges from the interplay between orbital properties and crystal symmetries, and does not depend on spin-orbit coupling.

I will discuss different aspects of the OHE in 2D materials and show that monolayers and bilayers of transition metal dichalcogenides (TMDs) exhibit OHE in their insulating phase [1]. When cut along appropriate directions, the TMDs host conducting edge-states, which cross their bulk gaps and can transport orbital angular momentum [2]. Our results offer the possibility of using TMDs for orbital current injection and orbital torque transfer that can surpass their spin equivalents.

[1] Tarik P. Cysne, Marcio Costa, Luis M. Canonico, M. Buongiorno Nardelli, R. B. Muniz, Tatiana G. Rappoport , "Disentangling orbital and valley Hall effects in bilayers of transition metal dichalcogenides", Phys. Rev. Lett. **126**, 056601(2021).

[2] Marcio Costa, Bruno Focassio, Tarik P. Cysne, Luis M. Canonico, Gabriel R. Schleder, Roberto B. Muniz, Adalberto Fazzio, Tatiana G. Rappoport, "Connecting Higher-Order Topology with the Orbital Hall Effect in Monolayers of Transition Metal Dichalcogenides", arXiv:2205.00997 **(To appear in PRL)**