# **Spin and Charge Transport in Two-dimensional systems in the Presence of Rashba Spin-Orbit Coupling**

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Abstract

Spintronics exploits the spin degree of freedom of the electron. In this context, via the microscopic mechanism of the spin-orbit coupling it becomes possible to convert charge currents into spin currents or spin accumulation as in the spin Hall and spin galvanic effects. The Rashba spin-orbit coupling, arising when inversion symmetry is broken at interfaces, has been shown to play a key role in a large variety of physical systems such as semiconductors, metals and graphene proximized to transition metal dichalcogenides. In this talk I will consider two-dimensional disordered electron systems in the presence of the Rashba spin-orbit coupling for two paradigmatic models: i) the two-dimensional electron gas; ii) graphene with Dirac-like dispersion relation. In both two models, the interplay of the Rashba spin-orbit coupling with disorder scattering manifests in a similar way, yielding a non-trivial connection between the spin Hall and spin galvanic effects. This behavior can be traced back to a specific feature of the Rashba spin-orbit coupling, which will be clarified by formulating the problem as a gauge theory with SU(2) symmetry. As extensions of the theory, I will also show how other spin-orbit effects can be incorporated, such as skew-scattering and side-jump for the two-dimensional electron gas or valley Zeeman for graphene, in order to provide an interpretation of the available experiments.