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Thema:  
Rashba spin-orbit coupling: a journey from the two-dimensional electron gas to the Dirac-graphene model

Abstract  
Rashba spin-orbit coupling was introduced in 1959 and applied to the two-dimensional electron gas in 1984 by Bychkov and Rashba. In the two-dimensional electron gas (2DEG), the Rashba spin-orbit coupling leads to a non-trivial connection among charge current, spin current and spin polarization yielding phenomena like the spin Hall effect and the spin galvanic effect. In more recent years, the Rashba spin-orbit coupling has been introduced also in the Dirac model for graphene. Despite the differences between the two models, the phenomena associated to the Rashba spin-orbit coupling share some common characteristics, which I will examine in my talk. In the first part, I will consider the 2DEG model with Rashba and Dresselhaus spin-orbit coupling. I will show how recent experimental results for the inverse spin galvanic effect can be understood by the interplay from intrinsic and extrinsic (i.e. from impurities) spin-orbit coupling. The SU(2) gauge theory description of the intrinsic spin-orbit coupling provides a transparent way to formulate a transport theory in terms of a generalized Boltzmann equation. In the second part I will consider the Dirac-Rashba model. I will show how the SU(2) gauge theory description, when used together with the Ward identities of quantum field theory, provides a full solution to the problem in the presence of disorder scattering. This is shown to be a powerful approach to unveil the diagrammatic structure of the theory. This will be used to discuss results for both the spin Hall and spin galvanic effects in the Dirac-Rashba model.

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