



Novel spin transport phenomena in two-dimensional metals with spin-orbit coupling

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Abstract

Spintronics is one of the most promising applications of two-dimensional materials with spin-orbit coupling. Recently, a lot of effort has been put into nonlocal transport measurements on adatoms (e.g. gold, hydrogen) decorated graphene due to its controversial spin-orbit coupling strength. In this talk, I will discuss our theoretical effort in understanding spin transport in adatoms decorated graphene. We derive a quantum Boltzmann transport equation that incorporates spin coherence in the presence of a collection of strongly coupled impurities [1]. The Boltzmann equation is solved using a microscopic scattering model [2] and a drift-velocity *ansatz* [3]. We found a novel scattering mechanism, termed the *anisotropic spin precession* scattering, that can qualitatively modify the transport behaviour; it leads to a large current-induced spin polarization and modifies the spin Hall effect. Next, based on the solutions of quantum Boltzmann equation, we formulate a phenomenological theory [4] to study non-local transport and we found two anomalous behaviours: the nonlocal resistance can take negative values in the absence of magnetic field and the Hanle precession curve can be asymmetric with reversing the magnetic field. These anomalous behaviours can help to identify the dominant spin-charge conversion mechanisms in two-dimensional metals with spin-orbit coupling.

[1] Chunli Huang, Yidong Chong and Miguel Cazalilla, Direct coupling between charge current and spin polarization by extrinsic mechanisms in graphene, *Phys Rev B*, **94** 085414 (2016)

[2] H.Y Yang, Chunli Huang, Hector Ochoa and Miguel Cazalilla, Extrinsic spin Hall effect from anisotropic Rashba spin-orbit coupling in graphene, *Phys Rev B*, **93** 085418 (2016)

[3] Chunli Huang, Yidong Chong, Giovanni Vignale and Miguel Cazalilla, Graphene electrodynamics in the presence of the extrinsic spin Hall effect, *Phys Rev B*, **93** 165429 (2016)

[4] Chunli Huang, Yidong Chong and Miguel Cazalilla, Anomalous nonlocal resistance and spin-charge conversion mechanisms in two-dimensional metals, arXiv:1702.04955 (2017)

About the Speaker

Chunli Huang received all his mandatory educations in Malaysia and he is the top-ten medalist of mathematics in the Unified Examination Certification. He completed his undergraduate at the National University of Singapore and was awarded the MRS (Materials Research Society) medal as the top student in the course. He is currently a PhD. student and a holder of Outstanding Oversea Chinese Studentship in the National Tsing Hua University at Taiwan China working with Prof. Miguel Cazalilla and Prof. Chong Yidong.