Spin injection and spin transport in a high mobility 2D electron gas

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Electrical generation and control of electron spins in semiconductors is the central theme in semiconductor spintronics. Effective spin injection into a two-dimensional electron gas (2DEG) is particularly desirable as it is prerequisite for many new functionalities in potential devices, with a Datta-Das spin field effect transistor [1] being a primary example. Whereas real progress in understanding of spin injection phenomena in bulk semiconductors has been achieved, effective spin injection into high mobility 2DEGs remains a relatively open matter.

In the first part of the talk I will discuss general issues related to electrical spin injection and detection in semiconductors, addressed in the so-called standard model of spin injection based on spin drift-diffusion equations. I will illustrate the discussion mainly with the results of our experiments on bulk GaAs-based structures with (Ga,Mn)As/GaAs spin Esaki diodes employed as spin injecting and detecting contacts.

In the second part I will focus on different aspects of experiments on spin injection in high mobility 2DEGs, while presenting the results of our investigations of structures with a 2DEG confined in an inverted (Al,Ga)As/GaAs heterojunction [2]. I will show and discuss large spin-valve signals observed in the investigated structures, measured both in *nonlocal* and *local* experimental configurations. I will consider the importance of ballistic effects in a spin injection process [3], which in some cases can be responsible for enhancement of the spin signal in comparison with the prediction of the standard model of spin injection. Furthermore, I will discuss conditions required for succesfull observation of a spin precession signal in high mobility 2DEG channels. Reliable spin precession measurements are of particular importance because they provide us direct information about spin transport parameters of the channel, like spin relaxation times or the spin diffusion constant.

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[3] K. Cheng and S. Zhang, *Phys. Rev. B* **92**, 214402 (2015).