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Abstract for an Invited Paper
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Electronic spin transport and spin precession in single graphene layers at room temperature.

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I will give a review of our experiments on spin injection, spin transport and spin precession in field effect transistors based on single graphene layers. We have employed a four terminal non-local measurement technique which allows us to fully separate the electronic charge and spin circuits. One pair of ferromagnetic electrodes is used as spin injectors, the other pair as spin detectors. By using different widths for the ferromagnetic electrodes we are able to control the coercive fields and prepare the magnetization direction of each with an applied magnetic field (in positive or negative x-direction). We observe clear signals due to spin diffusion from injector to detector electrodes. From the dependence of the spin signals on electrode spacing we obtain a spin relaxation length of 1.5 to 2 micrometer, and a corresponding spin relaxation time of about 100 ps [1]. These measurements are confirmed by Hanle-type spin precession measurements where the injected spins precess around a magnetic field applied perpendicular to the graphene plane. The spin signals only weakly depend on temperature (between 4.2 K and 300K), and also change little when the gate voltage is tuned from the metallic electron/hole regimes to the Dirac neutrality point. Recent experiments show that the spin relaxation times/lengths are similar for spin directions pointing in the graphene plane and perpendicular to the graphene plane [2]. Also the presence of an Al_2O_3 layer on top of the graphene does not significantly change the spin relaxation length and time. I will discuss these results in the light of existing theories for spin-orbit interaction in graphene. The implications for graphene spintronics and graphene qubits will be discussed.

[1] N. Tombros, C. Jozsa, M. Popinciuc, H.T. Jonkman, and B.J. van Wees, Nature 448, 571 (2007)
[2] N. Tombros et al.,submitted to Phys. Rev. lett.
[3] M. Popinciuc et al., submitted to Phys. Rev. B.
[4] C. Jozs et al., submitted to Phys. Rev. Lett.