Spin Dynamics and Spin Transport in 2D Materials

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2D materials provide a unique platform for investigating the properties of spin and valley degrees of freedom, which can be probed by optical methods and electrical transport methods. In this talk, I will present our latest results on spin dynamics and spin transport in graphene, transition metal dichalcogenides (TMD), and heterostructures of such materials. To investigate spin and valley dynamics, we employ the ultrafast optical pump-probe technique of time-resolved Kerr rotation. Figure 1 shows typical time-resolved spatial maps of spin-valley dynamics in a triangular island of WS_2 in response to a spin-valley polarized excitation. We are typically able to achieve spatial resolution of ~1 micron and temporal resolution of ~150 fs. Our studies have focused on the spatial mapping of spin-valley dynamics, photoluminescence properties, and the response to external fields [1]. For studies of spin transport, we have focused on the important challenge of spin manipulation in 2D devices. Specifically, we have made graphene spin valves on YIG substrates, which are shown to impart static and fluctuating exchange fields on the spin polarized carriers in graphene. This provides a route to fully modulate spin currents in graphene based on the in-plane orientation (θ) of the YIG magnetization (Figure 2) [2].

References

[1] Elizabeth J. Bushong, Yunqiu (Kelly) Luo, Kathleen M. McCreary, Michael J. Newburger, Simranjeet Singh, Berend T. Jonker, Roland K. Kawakami, arXiv:1602.03568 (2016).

[2] Simranjeet Singh, Jyoti Katoch, Tiancong Zhu, Keng-Yuan Meng, Tianyu Liu, Jack T. Brangham, Fengyuan Y. Yang, Michael Flatté, Roland K. Kawakami, arXiv:1610.08017 (2016).

Figures

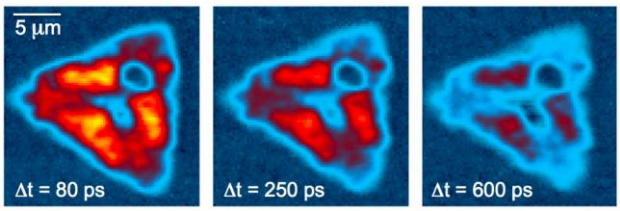

Figure 1: Spatial maps of spin-valley dynamics in monolayer WS_2

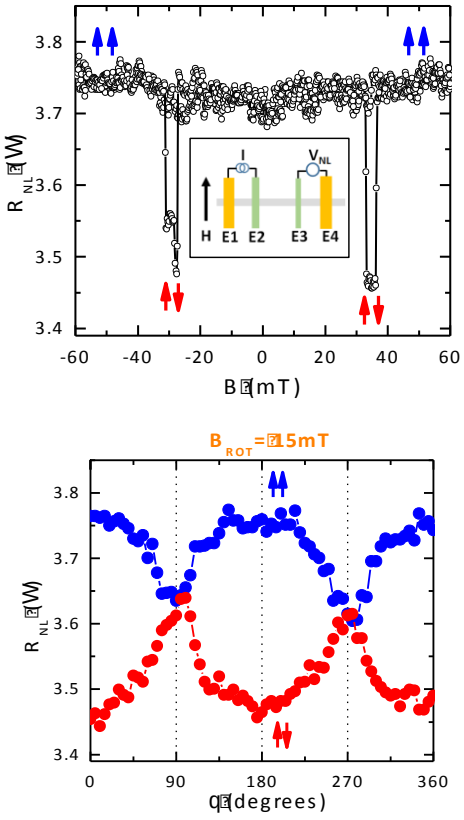

Figure 2: Modulation of spin currents in graphene by YIG magnetic gate