Exciton transport driven by spin excitations in a layered magnetic semiconductor

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Magnetic excitons have recently been discovered in magnetic van der Waals crystals. Akin to the highly effective strategies developed for electrons, the intimate coupling of these excitons to the spin degree of freedom could offer novel solutions for long-standing problems in optics, such as controlling the flow of charge-neutral optical excitations in solids. A particularly important material for fundamental research in this direction is the van der Waals antiferromagnetic semiconductor CrSBr. It supports tightly bound excitons that interact strongly with light [1], magnetic fields [2], and magnons [3].

In this talk, I will present our recent study on exciton transport in CrSBr. Key results of our experiments include ultrafast, nearly isotropic exciton propagation substantially enhanced at the Néel temperature, transient contraction and expansion of the exciton clouds at low temperatures, as well as superdiffusive exciton transport behavior in ultrathin layers. These signatures largely defy description by commonly known exciton transport mechanisms but can be related to interactions of excitons with optically excited spin currents in this material. More specifically, we propose that the drag forces exerted by such currents can effectively imprint characteristic properties of magnons and other spin excitations onto the motion of excitons. The universal nature of the underlying exciton-magnon scattering promises driving of excitons by spin currents not only in CrSBr, but also in other magnetic semiconductors and even non-magnetic materials by proximity in heterostructures, combining the rich physics of magneto-transport with optics and photonics.

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[2] Wilson, N. P. *et al.* Interlayer electronic coupling on demand in a 2D magnetic semiconductor. *Nature Materials* **20**, 1675 (2021).

[3] Bae, Y. J. *et al.* Exciton-coupled coherent magnons in a 2D semiconductor. *Nature* **609**, 282–286 (2022).

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