2nd Transnational Round Table on Magnonics, High-Frequency Spintronics, and Ultrafast Magnetism

Magnon transport in two dimensional (anti)ferromagnets using different manipulations

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Two-dimensional antiferromagnetic materials have huge potential to serve as important candidates in the advancements of spintronic devices. The analysis of the coherent dynamics of (anti)ferromagnetic order, alongside incoherent methods, such as magnon transport by electrical and thermal spin current generation is interesting to study because of efficient information transfer, ultrafast signal processing and microwave operations. Cornelissen et al.[1] (2015) first demonstrated the long distance magnon transport in a ferrimagnetic material Yttrium Iron Garnet($Y_3Fe_5O_{12}$) using a non-local geometry, i.e. using a pair of heavy metal contacts on the ferromagnetic material that would act as an injector-detector pair. Charge current from the injector is converted into spin current in the ferromagnet via Spin Hall Effect (SHE). The magnons get transported to the detector and the spin current gets picked up as a dc voltage via Inverse Spin Hall Effect (ISHE). Following its footsteps, non-local magnon transport using electrical and thermal manipulation has been shown to be possible by de Wal et al.[2] (2023) in two dimensional antiferromagnet Chromium Thiophosphate ($CrPS_4$).

$CrPS_4$ is an interesting 2D antiferromagnetic material to study because of its out of plane magnetisation, Neel temperature of ≈38 K and operation in the GHz regime. These properties make $CrPS_4$ a promising candidate to study coherent magnon transport as well. This can be achieved via coherent spin pumping, which involves driving magnons in a conventional magnetic material using a radio frequency (rf) magnetic field and hence injecting spins into non-magnetic materials such as metals, semiconductors, topological insulators, etc. This would imply that dc voltage signals are detected as a peak when the magnons are driven at their resonance frequency at a particular bias field [3][4]. Following the results of the previous experiments to determine magnon transport in the same material, experiments in coherent spin pumping could thus lead us to more information in the direction of magnon transport in van der Waals antiferromagnets.

References:

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