Non-local magnon transconductance in extended rare-earth magnetic garnet films

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Diodes are key components in electronics. Their prized property is to provide non-linear behavior such as asymmetric conductance which allows the transport in the forward direction while blocking it in the reverse. This feature is exploited in more complex structures such as the transistor. Recently it was thought that the same feature could occur in magnetic materials by electrically shifting the magnon chemical potential towards the energy band minimum. Highly non-linear behaviors were predicted for a bosonic system prone to Bose-Einstein condensation. In this field the highest benchmarks are expected to be obtained with rare-earth magnetic garnets, which have the lowest magnetic damping. It is the fundamental factor that moves the chemical potential as a function of an electrical signal.

Using non-local devices[1-4], we have performed a comprehensive study of the nonlinear transport properties of magnons, which are electrically emitted or absorbed inside extended YIG films by spin transfer effects via a YIG|Pt interface (see figure). In this talk, we reveal that the low-energy magnons which provide the spin-diode effect are competing with a featureless background of high-energy magnons. We will show however that there are several ways to make the low-energy magnons dominant. Doing that, we did not find evidence of a strong spin diode effect expressing a diverging increase of the magnon density. We observe instead a condensation limited by an enhancement of magnon-magnon relaxation rate, which caps the occupation of each mode below a saturation threshold. In other words, the reported nonlocal transport signal hints at coupled dynamics between numerous modes rather than the picture of a single dominant mode[5,6].

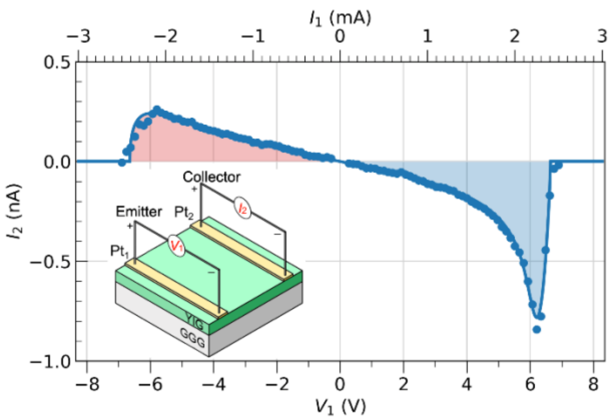

Fig.1: Asymmetric I-V characteristics of magnon transport in a non-local device (inset).

[1] L. J. Cornelissen *et.al.*, *Nat. Phys.* (2015), [2] Y. Kajiwara *et.al.*, *Nature* (2010), [3] S.T.B. Goennenwein *et.al.*, *Appl. Phys. Lett.* (2015), [4] M. Althammer, Phys. Status Solidi rapid research letters (2021), [5,6] R. Kohno *et.al.*, ArXiv2210.08304 (PartI) and ArXiv2210.08283 (PartII)