

## Dynamic stability in spin Hall micro-bars: Towards anti-magnon mediated magnon amplification

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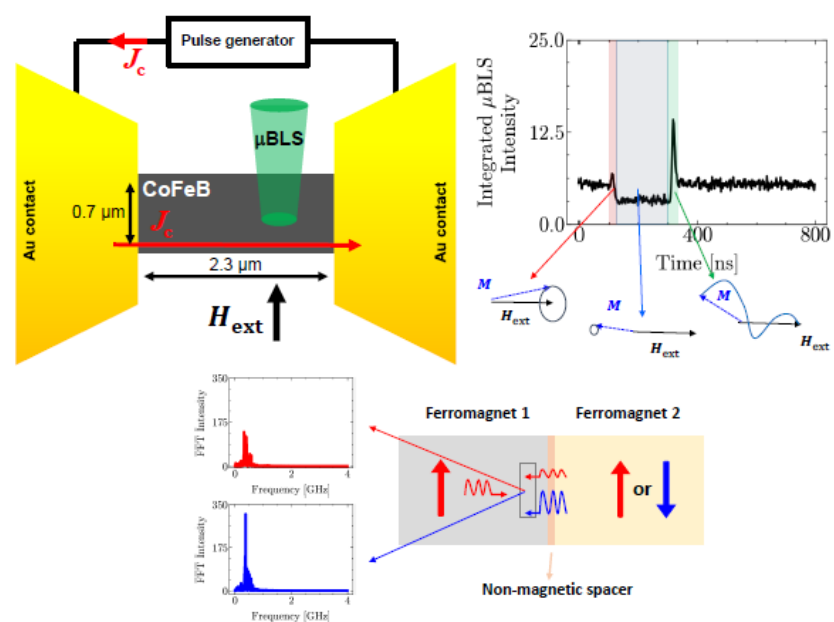
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Magnons, the quanta of spin waves, are quasi-particles whose excitation increases the magnetic energy of the system. Conversely, anti-magnons are the quasi-particles that decrease the magnetic energy of the system. Theoretically, such excitations can be realized in systems where the magnetization is brought to a dynamically stable yet energetically unfavourable state [1]. We conduct experiments employing micro-focused Brillouin light scattering spectroscopy (see Fig. 1 left side) that depict the aforementioned dynamically stable state in spin Hall micro-bars (see Fig. 1 right side). We follow this by micromagnetic simulations to show that we can use the dynamically stable state (anti-magnonic state) to amplify magnons via magnon-anti-magnon coupling based on the magnonic Klein paradox [1, 2] (see Fig. 1 bottom part). Furthermore, we propose a method of amplifying propagating spin waves by means of spin torque oscillators operating in the anti-magnonic state. These findings open perspectives to experimentally investigate anti-magnon mediated magnon dynamics in similar systems.

Fig. 1. (Top left) Experimental setup highlighting the employment of micro-focused Brillouin light scattering spectroscopy to investigate magnetization dynamics in 1.7 nm thin Cobalt-Iron-Boron (CoFeB) micro-bars. (Top right) Time resolved measurements showing the different states of magnetization prior to, during and post pulsed excitation. (Bottom) Simulated results depicting magnon signal amplification mediated by anti-magnon coupling.



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#### References:

- [1] J. S. Harms, et al, *Antimagnonics*, AIP Advances **14**, 025303 (2024).
- [2] J. S. Harms, et al, *Enhanced magnon spin current using the bosonic Klein paradox*, Phys. Rev. Applied **18**, 064026 (2022).