Energy-efficient generation of high-frequency spin waves in BiYIG/Co-based heterostructures using laser pulses

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Spintronics and magnonics aim to utilize collective spin excitations, known as spin waves (SWs), as information carriers for future information-processing technologies. A key challenge for high-speed operation is achieving high-frequency SWs with low damping at weak magnetic fields. Yttrium iron garnet (YIG) is particularly attractive due to its ultra-low damping; however, its low saturation magnetization limits SW frequencies to only a few gigahertz at low fields, constraining high-speed applications. In this talk, I will present my research on the generation and control of high-frequency SWs in nanoscale dielectric thin films of bismuth-doped YIG (BiYIG) using femtosecond laser pulses. In addition to low damping, BiYIG exhibits a very large magneto-optical Faraday effect, making it well suited for emerging photo-magnonic devices. A particular focus will be placed on recent results demonstrating energy-efficient excitation of high-frequency SWs in BiYIG/Co-based heterostructures [1]. We show that femtosecond laser pulses can trigger high-frequency SWs in BiYIG-based heterostructures at very low laser energy densities, conditions under which spin precession cannot be excited in bare BiYIG. This energy-efficient excitation is attributed to ultrafast changes in the interlayer exchange field acting on BiYIG, induced by rapid laser heating of the adjacent Co layer. Finally, I will highlight the importance of combining complementary ultrafast magneto-optical techniques, such as pump-probe Faraday and Kerr rotation measurements, for advancing the fundamental understanding of ultrafast magnetization dynamics.

References:

[1] D. S. Pamarthi et al., Physical Review Applied 24, 034074 (2025).