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XPEEM Imaging of Magneto-acoustic Waves at GHz Frequency

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Magnetization oscillations in thin films with spatial variations at the nano- and microscale are interesting in the development devices for high-speed and low-power signal processing compatible with existing technology. Surface acoustic waves (SAWs) are an alternative to magnetic fields in the excitation and control of magnetization dynamics, which use electric fields in order to induce magnetoelectric and magneto-elastic effects [1]. Casals et al. employed 500 MHz SAWs to create long range magnetization waves in Ni thin films [2]. More recently we have extended this method to include antiferromagnetic CuMnAs. For the observations we used PhotoEmission Electron Microscopy (PEEM) with magnetic contrast based on x-ray magnetic linear dichroism (XMLD), and the SAW excitation synchronized with the x-ray illumination.

Wadley et al. demonstrated the control of antiferromagnetic (AFM) domains in CuMnAs by electrical currents [3]. In principle, alternative switching methods such as the magnetoelastic effect should be equally possible but are so far relatively unexplored in AFM materials. We have for the first time detected antiferromagnetic magneto-acoustic waves in epitaxial CuMnAs films excited by SAW in the GaAs substrate. On the other hand, exciting magneto-acoustic waves at higher frequencies, approaching the intrinsic ferromagnetic resonance frequencies, can lead to higher amplitudes, larger propagating distance of magnons and increased phonon-magnon interaction. For ferromagnetic Ni thin films on LiNbO₃ we have already increased the frequency into the GHz range.

References

- [1] M. Foerster et al., Nature Comm. 8, 407 (2017).
- [2] B. Casals et al., Phys. Rev. Lett. 124, 137202 (2020).
- [3] P. Wadley et al., Science 351, 587 (2016).

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No

Primary author: Mr KHALIQ, Muhammad Waqas (ALBA Synchrotron)

Co-authors: Dr AMIN, Oliver (School of Physics and Astronomy, University of Nottingham); Dr HERNÁNDEZ-MÍNGUEZ, Alberto (Paul Drude Institute for Solid State Electronics); Dr CASALS, Blai (Institut Català de Nanociència i Nanotecnologia (ICN2)); Mr ROVIROLA, Marc (Dept. of Condensed Matter Physics, University of Barcelona); Dr OMARI, Khalid (Dept. of Electronic Engineering, Royal Holloway, University of London); Dr RUIZ-GOMEZ, Sandra (Max Planck Institute for Chemical Physics of Solids); Dr FINIZIO, Simone (Swiss Light Source, Paul Scherrer Institute); Prof. EDMONDS, Kevin (School of Physics and Astronomy, University of Nottingham); Dr ABALLE, Lucia (ALBA Synchrotron); NIÑO ORTI, Miguel Angel (ALBA Synchrotron); Dr HERNÁNDEZ, Joan Manel (Dept. of Condensed Matter Physics, University of Barcelona); Dr MACIA, Ferran (Dept. of Condensed Matter Physics, University of Barcelona); Dr WADLEY, Peter (School of Physics and Astronomy, University of Nottingham); Dr FOERSTER, Michael Joachim Ulrich (ALBA Synchrotron)

Presenter: Mr KHALIQ, Muhammad Waqas (ALBA Synchrotron)

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