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National Institute of Standards and Technology (NIST), Boulder, CO

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Tabletop, High-Frequency, Layer- and Element-Specific XFMR Spectroscopy Detected with Extreme Ultraviolet Light

X-ray detected ferromagnetic resonance (XFMR) spectroscopy provides a unique tool for measuring magnetic dynamics at and across interfaces, due to its ability to measure individually the ferromagnetic resonance of each element in a sample. Until now, XFMR has generally been shown at frequencies below 12 GHz, and has been performed only at synchrotron sources. I will present a laboratory-scale instrument developed at NIST-Boulder that uses ultrafast, extreme ultraviolet (EUV) light to perform XFMR spectroscopy. It exhibits a timing jitter of lower than 1.2ps between the microwave excitation and the EUV pulses, even at frequencies exceeding 60 GHz. We used this instrument to measure three samples on opaque Si substrates: permalloy (8.5 GHz), a Co-Fe alloy (17 GHz), and a Ni/TaOx/Fe multilayer (8.5 GHz, exhibiting element-specific dynamics). These measurements highlight the ability to perform high-frequency, element- and/or layer-resolved XFMR. The applicability to higher frequencies enables XFMR measurements of materials with high magnetic anisotropy, in addition to ferrimagnets, antiferromagnets, and high-wavevector spinwaves in nanodevices. In the future, we will be able to utilize the coherence of the source and combine this capability with dynamic, nanoscale, lensless imaging techniques such as ptychography and holography, and measure dynamics and transport in active devices.

Short Bio

Michael Tanksalvala is a physicist in the Spin Electronics group in the Physical Measurement Laboratory at NIST in Boulder, CO. He received his PhD from University of Colorado at Boulder in 2022, where he developed a technique for performing non-destructive, 3D characterization of multilayered nanostructures, called EUV ptychographic reflectometry. His current research extends this approach to several instruments under development for characterizing nano-devices and magnetic materials, as well as experiments using Brillouin Light-Scattering spectroscopy (BLS).