Abstract: Ferromagnetic Resonance dynamics at high microwave powers in low spin-damping Ferrimagnets, Y1

Understanding non-linear spin dynamics in the field of magnetics has become ever so important for the exploration of new paradigms. One of the important ones amongst them is the intersection of magnonics (magnon- based devices) with microwave fields. Magnons (or spin-waves) are quantized excitations of magnetizations and understanding their non-linear behavior (especially under microwave excitation), is important from both fundamental as well as applications points of view. Due to the myriad of physical phenomena active in a magnetic material, it becomes extremely difficult and often impossible to study various phenomena independently using experiments. Often, only averaged over properties are accessible using modern experimental techniques. Further, lack of sufficient spatial resolution makes present experimental studies unsuitable for fine-scale studies.

Consequently, simulations are an important way forward.

While magnons have characteristic wave-lengths of few hundreds of nanometers (nm), the devices themselves are often 100s of micrometers or more. Moreover, the time to achieve steady state can be as high as thousands of nanoseconds. This has to be done at a time-step of few 100s of femtoseconds. Moreover, higher number of cells are needed to allow sufficient degrees of freedom to capture the essential physics. All such features of the magnetic physics and thereby those of non-linear processes, make parallel computation well suited for explorations of magnetic properties.

Current Specific Goals: Our larger goal is to understand the non-linear interactions amongst the excited magnons that takes place usually via a multitude of processes like three- and four-magnon processes, wherein said number of particles interact to give interesting changes in quantities of physical interest like absorption, propagation etc. Three important and related processes: Non-linear damping mechanisms, phase-mismatch mechanisms and transient time would be the main focus of our study, as currently these processes remain far from understood.

Software: We have developed a CUDA-GPU based software that allows us to perform these studies. This code has been optimized specifically for our studies (in terms of magnetic-device geometries, computational cell-sizes and data-writes etc.).