

# Special URA physics student seminar

**Friday, February 20, 11:00 am. Osborne A204**

## **Nonlinear harmonics in thin magnetic films with interfacial Dzyaloshinskii-Moriya interactions**



Harmonic generation occurs in many different places, such as musical instruments and bird calls. This study looks at how Dzyaloshinskii-Moriya Interactions (DMI) effects the creation of harmonics in spin waves. Here numerical and analytical methods are used to analyze the Landau-Lifshitz equation for a narrow Permalloy stripe with interfacial DMI. We found in this study that if the static field is perpendicular to the stripe, spin waves traveling in one direction can have harmonics that are more than 50 times larger than for waves moving oppositely. Also, when the external field is parallel to the stripe and DMI is present both even and odd harmonics are generated, but without DMI only the odd harmonics appear. This potentially offers a different way of measuring the DMI strength in a material. In systems with larger nonlinearity, through an increased driving field or a different choice of driving frequency, we found frequency combs can also appear.

## **Increasing the dynamic coupling in artificial spin ices through geometry design**

Artificial spin ice (ASI) is a magnetic system that involves a lattice of many magnetic elements of nanoscopic dimensions, i.e., nanomagnets. ASIs have potential applications in microwave devices and fundamental elements for unconventional computing. To be functional, ASI geometries must be optimized for stronger dynamic coupling between nanomagnets. In this talk, I will discuss the impact of nanomagnet's shape on the ferromagnetic resonance of ASI. Additionally, we study a trilayer system where two nanoislands are stacked and then placed in a square arrangement. Each sublayer is subject to Dzyaloshinskii-Moriya interaction (DMI) and investigate its effect on the structure's ferromagnetic resonance. This research provides additional design considerations to use ASIs as microwave components or unconventional computing building blocks.

