Nonlinear Coupled Magnonics

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Tailored light excitation and nonlinear control of lattice vibrations have emerged as powerful strategies to manipulate the properties of quantum materials out of equilibrium. Generalizing the use of coherent phonon-phonon interactions to nonlinear couplings among other types of collective modes would open unprecedented opportunities in the design of novel dynamic functionalities in solids. For example, the collective excitations of magnetic order – magnons – can carry quantum information with little energy dissipation, and their coherent and nonlinear control would provide an attractive route to achieve collective-mode-based information processing and storage in forthcoming spintronics and quantum information science. In this talk, I will show that intense terahertz (THz) fields can initiate processes of magnon up-conversion and magnon mixing mediated by an intermediate magnetic resonance. By using a suite of advanced spectroscopic tools, including a newly demonstrated two-dimensional THz polarimetry technique, we unveil these anharmonic magnon coupling phenomena in a canted antiferromagnet. These results demonstrate a route to inducing desirable energy transfer pathways between coherent magnons in solids and pave the way for a new era in the development of ultrafast control of magnetism.