Harnessing Spin Relaxation in Multipolar Magnets and 2D Quantum Defects: Towards Sub-THz Spintronics

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Wednesday, Nov. 19th @ 2:00 pm in BRK 1001

Coffee and snacks served before seminar

also on [MS Teams]

Abstract: Spin systems underpin a growing range of emerging technologies — from probabilistic bits for stochastic computing to quantum bits for sensing and information processing. A central question in these platforms is how spins relax and lose memory, which in conventional spintronic systems mostly occurs at gigahertz frequency scale, limiting operational speed and bandwidth.

In this talk, we will explore unconventional spin platforms where relaxation occurs at much higher frequencies and on faster timescales. In the first example, we will present chiral magnets as a platform where the underlying order parameter relaxes on picosecond timescales and is electrically tunable, enabling ultrafast switching for spintronic devices [1,2]. In the second example, we demonstrate spin relaxation-based 2D quantum sensors in hexagonal boron nitride, operating in previously inaccessible high-field and sub-terahertz regimes [3]. Together, these studies show how spin relaxation across diverse platforms can enable the next generation of sub-THz spintronic and quantum technologies.

[1] Konakanchi et. al. "Electrically Tunable Picosecond-Scale Octupole Fluctuations in Chiral Antiferromagnets" Phys. Rev. Lett. 135, 136704 (2025) (Editor's suggestion)

[2] Kang et. al. "Octupole-driven spin-transfer torque switching of all-antiferromagnetic tunnel junctions" arXiv:2509.03026

[3] Solanki et. al. "Sub-Terahertz Spin Relaxation Dynamics of Boron-Vacancy Centers in Hexagonal Boron Nitride" arXiv:2507.16786

Bio: Pramey Upadhyaya is an Associate Professor of Electrical and Computer Engineering at the Purdue University. Before joining Purdue, Pramey was a postdoctoral scholar in the Physics and Astronomy Department, University of California Los Angeles. He earned his bachelor's degree in Electrical Engineering from the Indian Institute of Technology Kharagpur, India, in 2009, and the master's and Ph.D. degree in Electrical Engineering department from the University of California Los Angeles, USA, in 2011 and 2015, respectively. His research has explored the theory of classical and quantum spintronic phenomenon and their device applications, enabled by electrical and thermal control of magnetism. Along with his teammates, this work has resulted in one of the earliest demonstrations of current-induced room-temperature skyrmion manipulations, spin torque switching by topological surface states and quantum sensing of spintronic phenomena. He is a recipient of NSF CAREER (2020), Purdue Outstanding Engineering Teacher Award, and Qualcomm Innovation fellowship (2013).

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