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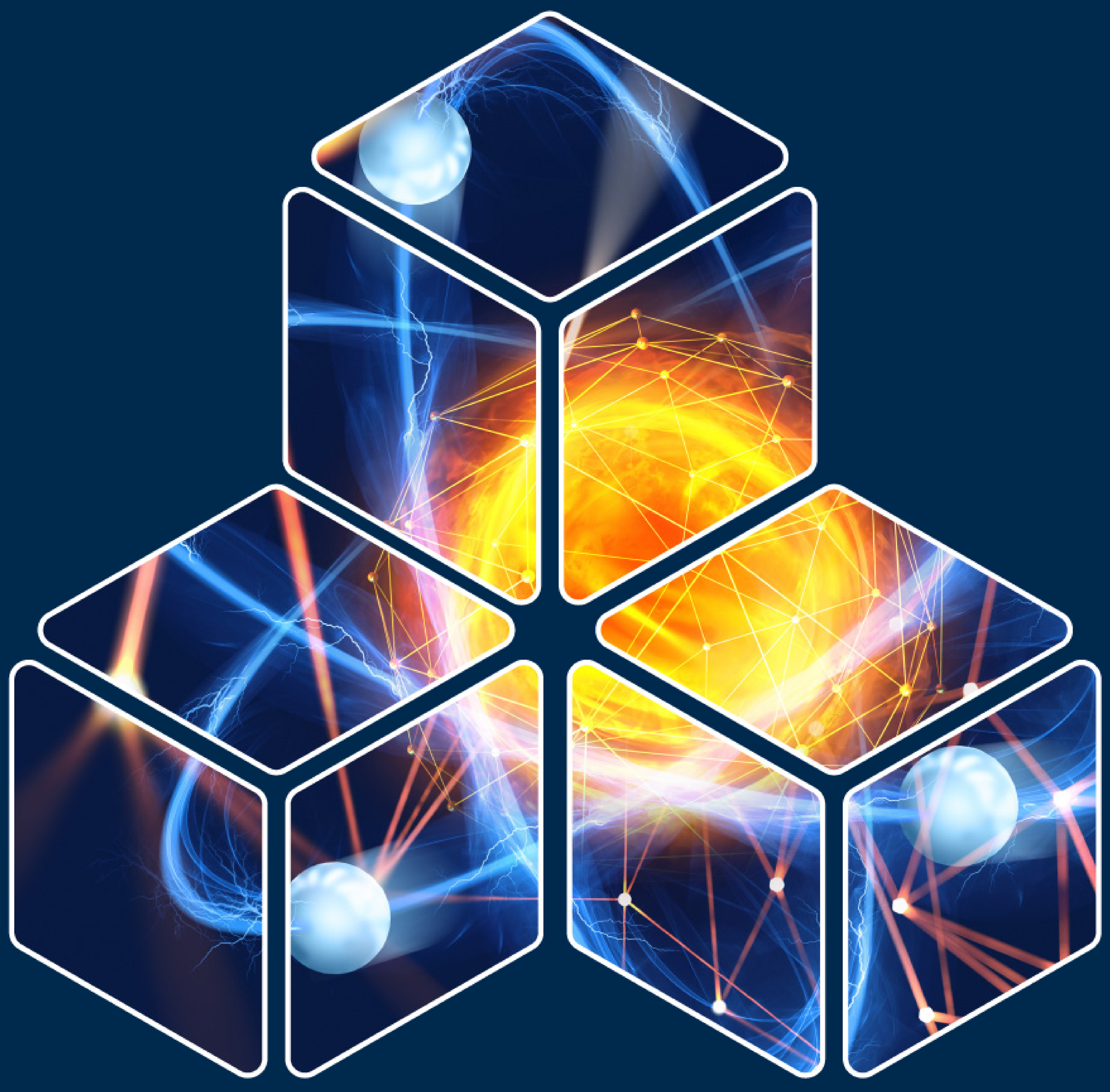

NNCI Computation Webinar

September 28, 2022 | 4:00 p.m. - 5:00 p.m. ET

Theoretical Exploration of Energy Efficient Spintronics Devices

Professor Tony Low | Department of Electrical and Computer Engineering, University of Minnesota

Abstract: With great advances by the spintronics device and materials communities, magnetic tunnel junctions (MTJ) have been demonstrated to be the only passive device that can function simultaneously for digital, memory, and analog in-memory computing, among other applications. However, several key technological roadblocks remain, such as its energy efficiency, switching speed, and tunneling magnetoresistance ratio (TMR). A significant performance boost in all these metrics, by at least two orders of magnitude, is required, calling for a fundamental and out-of-the-box approach to rethinking MTJ devices. In this talk, we will introduce a new class of topological magnetic Weyl semimetals. We discuss how electrons are imbued with a new degree of freedom known as chirality. The electron chirality is locked to its magnetization (order parameter). Our theoretical calculations via non-equilibrium Green's function show that a TMR of 10,000% can be obtained in the presence of realistic thermal fluctuations. In recent years, a key driver in low energy magnetization switching has been the use of spin orbit torque materials in spintronics. In this talk, I will review the physics and origin of spin orbit torques and their different flavors, such as Rashba Edelstein, spin Hall effect, and valley-spin Hall. I will discuss our modeling results in utilizing nanostructured topological insulators to engineer giant Rashba Edelstein effect, and the experimental measurement of this effect in sputtered bismuth compounds. I will also discuss our recent work in assessing the viability of utilizing the valley Hall physics in transition metal dichalcogenides for switching a proximal magnet. Lastly, I discuss recent experiments in the study of spin-orbit torques in graphene on transition metal dichalcogenides, the physical origin of these torques and the influence of twist angles. We briefly discuss the theoretical methods of spin Hall effect calculations within the linear response theory.

Bio: Tony Low is the Paul Palmberg Professor in the Department of Electrical and Computer Engineering, and a member of the graduate faculty in the Physics Department at the University of Minnesota. He leads the Materials and Device Modeling group, focusing on the theory of electronic transport and electromagnetic phenomena at the nanoscale and their impact on next generation nanoelectronics, spintronics, and plasmonic devices. Low is among the Clarivate Analytics Highly Cited Researchers. Prior to joining the department, Low worked as a research scientist and theorist in various experimental groups at Columbia University, Yale University, and IBM Thomas J. Watson Research. While at IBM, from 2011-2014, Low served as an industry liaison to various Universities under the Nanoelectronics Research Initiative with the goal of finding the next electronics switch. Low obtained his Ph.D. from the National University of Singapore, and then a postdoctoral associate at Purdue University. He received the George W. Taylor award for distinguished research (2021), the McKnight Presidential fellowship (2019), the IBM Pat Goldberg memorial best paper award (2015).

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