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MICRO - NANO SEMINARS

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4:00 pm – Room 3-270

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Seeing "Magnetic Light": Quantifying and Exploiting Magnetic Dipole Transitions

Abstract
Although it is often assumed that all light-matter interactions at optical frequencies are mediated by electric dipole transitions, strong optical frequency magnetic dipoles do exist. In fact, we see magnetic dipole emission every day from the many lanthanide ions (such as trivalent europium and erbium) that help to illuminate everything from fluorescent lighting to telecom fiber amplifiers. Higher-order processes such as magnetic dipole and electric quadrupole transitions also play an important part in the light emission from transition metal ions and semiconductor quantum dots.

In this presentation, we will experimentally characterize the "forbidden" transitions in a range of solid-state emitters and investigate their applications and implications for nanophotonics. We will examine the electric dipole approximation commonly used to describe light-matter interactions and discuss naturally occurring systems that exhibit higher-order magnetic dipole and electric quadrupole emission. We will illustrate how these nanoscale quantum transitions can provide both a new way to probe magnetic light-matter interactions and a new degree of design freedom for active electronic and photonic devices. Specifically, we will demonstrate how the different symmetries of multipolar transitions can be exploited to identify, quantify, and control light emission, even at sub-lifetime scales. We will also show how these techniques can be extended to study oriented excitons in layered nanomaterials such as molybdenum disulfide (MoS_2) and organic semiconductors such as PTCDA.

Biography

Rashid Zia is the Manning Assistant Professor of Engineering and of Physics at Brown University. Rashid graduated in 2001 from Brown University with a combined A.B. in English and American Literature and Sc.B. in Engineering. He then received both his M.S. and Ph.D. in Electrical Engineering from Stanford University, where he worked in the field of plasmonics and near-field optics as the first graduate student in the laboratory of Mark Brongersma. Rashid's research group at Brown works at the interface of electrical engineering, materials science, optical physics, and physical chemistry to study how light interacts with solid-state quantum emitters, including atoms, defect centers, ions, molecules, and quantum dots. As a faculty member, Rashid has received a National Science Foundation CAREER Award and a Department of Defense nominated Presidential Early Career Award for Scientists and Engineers (PECASE), and he has served as a Fellow of the National Forum on the Future of Liberal Education. Rashid is also the lead PI for a new Multidisciplinary University Research Initiative (MURI) on Quantum Metaphotonics & Metamaterials sponsored by the Air Force Office of Scientific Research.

Lab Website: www.zia-lab.com

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Light refreshments will be served. For more information, please contact Theresa Werth at theresaw@mit.edu.