

University of Miami, Physics Department Colloquium

Date: Wednesday, Oct 14, 2026
Time: 4:00 pm – 5:00 pm
Location: Physics Library – Rm 335, Knight Physics Building

Exchange-Narrowed Triplet Excitons in Single Crystals as Optically Addressable Quantum Sensors

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Abstract

Optically addressable molecular spin systems offer an attractive platform for quantum sensing because their electronic and spin properties can be engineered synthetically, while optical excitation provides routes to spin initialization and readout. At room temperature, however, magnetic inhomogeneity can broaden spin resonances and obscure spin dynamics. Here, we show that rapid intermolecular exchange between photoexcited triplet excitons can instead dynamically suppress this inhomogeneity.

Photoexcitation of a charge-transfer molecular cocrystal generates strongly spin-polarized triplet excitons localized predominantly on the electron donor molecules. The exchange narrowing, in which rapid interactions among triplet excitons dynamically average variations in their local magnetic environments. The linewidth therefore provides a spectroscopic connection between exciton dynamics and spin evolution.

Microwave excitation of these exchange-narrowed triplet states also produces a measurable change in photoluminescence at room temperature, demonstrating optical detection of spin resonance. These results establish exciton exchange as a molecular design parameter for suppressing magnetic disorder and provide a route toward optically addressable molecular spin ensembles for room-temperature quantum sensing.

Biography



Dr. Haochuan Mao is currently an Assistant Professor of Chemistry and Biochemistry and Quantum Initiative at Florida State University. He obtained his B.S. in Chemistry from Nanjing University in 2017 and Ph.D. in Physical Organic Chemistry from Northwestern University in 2022. From 2022 to 2025, he was a postdoctoral scholar at University of California-San Diego. His research interest includes developing spectroscopic methods to understand spin dynamics, harnessing spin polarization of excited molecules for quantum information sciences, spectroscopy guided design and synthesis of molecular qubits. He is a recipient of the First-year Assistant Professor Award at FSU in 2025.