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# University of Miami, Physics Department Colloquium

**Date:** Wednesday, Nov 15, 2023
**Time:** 4:00 pm – 5:00 pm
**Location:** Wilder Auditorium – Rm 112, Knight Physics Building

## Exploring Many-Body Physics with Single Quantum Entities for Quantum Information Science

**Dr. Hebin Li,** Florida International University

**Abstract**

Future scalable and reliable universal quantum computers can be more superior than classical computers for solving certain problems. To fully harness the power of quantum mechanics, the quantum computing platform must be a many-body system with interacting or coupled quantum entities (qubits). For example, entangling multiple qubits requires coupling and coherence. The behavior of an assemble of interacting particles cannot be understood by a simple extrapolation of the microscopic lawas of single particles. Instead, entirely new properties can appear at each level of complexity, as pointed out by P.W. Anderson in 1972. Experimentally understanding new principles and laws in many-body systems is essential for both fundamental many-body physics and ultimately providing practical solutions for future scalable and reliable quantum computers.

In this talk, I will present our work in exploring many-body systems that consist of single quantum entities including single atoms and solid-state-based atom-like entities. Recent advances in the preparation of these exotic singe quantum entities and in coherent spectroscopy provide unprecedented opportutnties. We can deterministically prepare a few- or many-body quantum system of single quantum entities using a bottom-up approach and use ultrafast coherent spectroscopy to study many-body properties in these systems. For example, our results revealed long-range dipole-dipole interaction between atoms with separation up to tens of micrometers. We have also observed multi-atom Dicke states with a scalable and deterministic number of atoms from two to eight atoms, providing the prerequisite for generating entangled states of up to eight atoms. The study of these systems contributes to fundamental understanding of many-body physics as well as potential applications in quantum information science.

**Biography**

Dr. Hebin Li is currently an associate professor in the Department of Physics at Florida Interanational University (FIU). He received his BS in physics from Wuhan University and his PhD in physics from Texas A&M University in 2010. After three-years of postdoctoral study at JILA, a joint institute of University of Colorado at Boulder and National Institute of Standards and Technology, Dr. Li joined FIU as an assistant professor in 2013 and was later promoted to an associate professor in 2019. During his tenure at FIU, Dr. Li has established a successful research program with a well-equiped ultrafast spectroscopy and quantum optics lab. His research interest focuses on experimental study of many-body quantum systems and their potential applications in quantum information science. Dr. Li is a Senior Member of Optica (formerly OSA). He has won awards including William R. Jones Oustanding Mentor Award (2021), Army Research Lab Summer Faculty (2020), FIU Top Scholar (2020), FIU CASE Research Award (2017, 2020, 2023) and Engagement Award (2023), and FIU Faculty Senate Excellence in Research Award (2023).