Alex Sushkov – Colloquium Seminar – April 3, 2025
Boston University

Title:
Nuclear magnetic resonance at the quantum sensitivity limit

Abstract:
Quantum science tools have been pivotal in various precision experiments, such as gravitational wave detectors, atomic clocks, and searches for new fundamental physics and axion dark matter. In experiments with ensembles of spin qubits, the standard quantum limit on sensitivity scales with the inverse square root of the number of spins. Platforms such as cold atoms, atomic vapor cells, and color centers in solids can operate in the regime where this spin projection noise dominates detection of ensemble dynamics. Increasing ensemble size is a promising way to enhance sensitivity. The challenge is that this requires a corresponding reduction in other noise sources. I will present precision nuclear magnetic resonance measurements on macroscopic ensembles of 10^{21} nuclear spins, with sensitivity limited by the quantum spin projection noise. Additionally, I will discuss the creation and utilization of spin squeezing in such macroscopic spin ensembles.

Bio:
Alex Sushkov's research focuses on how the tools of quantum information science can be applied to precision sensing and metrology. His PhD from UC Berkeley concentrated on sensitive atomic magnetometry and magnetic resonance, and his postdoctoral work included measurements of the quantum Casimir effect and nanoscale magnetic resonance measurements with nitrogen-vacancy centers in diamond. He now leads an experimental group that focuses on precision magnetic resonance and searches for ultra-light axion dark matter and other beyond-

standard-model physics. He is also exploring how nanoscale sensing can shed new light on dynamics of many-body quantum systems. He was awarded the Alfred P. Sloan Research Fellowship, the NSF CAREER award, and the Moore Foundation Experimental Physics Investigators Fellowship.