

CONDENSED MATTER COLLOQUIUM SERIES

#Ankara

Raffi Budakian

University of Waterloo



Nuclear Magnetic Resonance Diffraction: Probing Structure and Dynamics at the Atomic Scale

Advances in quantum control and ultrasensitive spin detection are opening new opportunities to investigate the structure and dynamics of condensed matter at the atomic scale. In this talk, I will introduce nuclear magnetic resonance diffraction (NMRd), a technique that exploits the same principle of coherent interference underlying Bragg diffraction to probe the spatial arrangement of nuclear spins. In NMRd, nuclear spins evolving in a uniform magnetic field gradient acquire a spatially varying phase, forming a helical spin texture whose wavelength can be controlled by the gradient strength and evolution time. When this wavelength is commensurate with the crystal lattice, the spins coherently rephase to produce a diffraction echo, analogous to a Bragg diffraction peak. Unlike conventional diffraction, NMRd offers the chemical selectivity of magnetic resonance and the ability to probe spatial correlations and dynamics in interacting spin systems.

I will present two recent experimental advances demonstrating NMRd with Angstrom-scale spatial resolution. First, I will describe phase-sensitive measurements of periodic nuclear spin correlations, demonstrating spatial encoding at a resolution beyond that previously achieved with magnetic resonance imaging (MRI). I will then show how NMRd can be extended beyond structural characterization to investigate many-body spin dynamics, using measurements of nuclear spin transport in a three-dimensional network of dipolar-coupled ^{31}P spins in indium phosphide (InP). Together, these results establish NMRd as a powerful approach for investigating atomic-scale structure, spin correlations, and dynamics in condensed matter systems.

After earning his bachelor's, master's and PhD degrees in physics from the University of California, Los Angeles, Raffi Budakian was a visiting scientist at the IBM Almaden Research Centre. The World Technology Network awarded him the World Technology Award in 2005 for his work in the detection and manipulation of electron spins. That same year Budakian joined the University of Illinois at Urbana- Champaign. Budakian joined the Institute of Quantum Computing (IQC) as the University of Waterloo Endowed Chair in Nanotechnology in Waterloo's Physics and Astronomy Department.

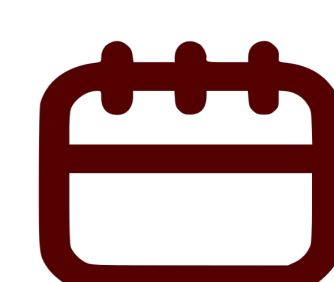
His work in the past decade has focused on developing the experimental tools for ultra sensitive detection of electron and nuclear spins. At IQC, he will explore applying these tools to address fundamental questions ranging from biology to quantum information.

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If you have any queries, please contact okte@fen.bilkent.edu.tr

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November, 17
Tuesday



19:00, (Ankara Time)



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