Jan 13, 2026

Time: 2:30 - 4:00 PM
Location: AERB 100

Quantum materials for next-generation quantum information

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ABSTRACT:

Quantum materials have emerged as versatile platforms for exploring emergent phenomena through atomic-scale engineering, yet their integration into quantum information technologies remains limited. In this talk, I will discuss how intrinsic symmetries and microwave responses in two-dimensional (2D) materials can be precisely engineered, and how these capabilities open new pathways for quantum information science.

For symmetry engineering, I will introduce a systematic approach to designing point group symmetries in twisted 2D materials, enabling emergent optical nonlinearities and selection rules that do not exist in naturally occurring 2D materials. For microwave engineering, I will present the discovery of discrete magnon standing wave modes and emergent magnon-phonon nonlinearities in atomically thin magnets, revealing new opportunities for atomic-scale control over magnonic responses. Together, these advances establish foundational principles for next-generation quantum device architectures – including quantum memories, quantum networks, and hybrid magnon-spin qubit systems – that promise enhanced storage capacity, multi-qubit connectivity, and processing speeds.

BIOGRAPHY:

Dr. Bumho Kim received his B.S. and M.S. in Materials Science and Engineering from Seoul National University. He earned his Ph.D. in Mechanical Engineering from Columbia University, where he worked with Professor James Hone on the synthesis and characterization of 2D quantum materials. He is currently a postdoctoral researcher at the University of Pennsylvania, working with Professor Bo Zhen, studying nonlinear, ultrafast, and THz spectroscopy in a variety of quantum devices, including twisted 2D materials and silicon quantum dots. His research focuses on developing quantum materials for next-generation quantum information technologies.