Functional Materials and Quantum Devices: Toward Ge Hole Spin Qubits

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Functional materials play a central role in enabling next-generation energy and information technologies. In this talk, I will present an overview of several research thrusts in my group at North Carolina State University, including thermoelectric materials and devices, topological materials design, and electromagnetic-field interactions with materials. These efforts aim to engineer materials and device architectures that couple electronic, thermal, and spin degrees of freedom to achieve new functionality.

The second part of the talk will focus on gate-defined quantum-dot hole spin qubits in germanium. Group-IV Ge/SiGe quantum wells provide an attractive platform for quantum computing due to strong spin-orbit coupling, compatibility with semiconductor fabrication, and the absence of valley degeneracy challenges present in silicon. I will discuss device concepts, materials considerations, and opportunities for realizing scalable hole-spin qubit architectures in Ge.