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Nanofabrication and integration of Quantum Spin Liquid materials into test structures and devices.

Quantum Spin Liquids (QSLs) emerge in frustrated magnetic materials where spins remain disordered even at 0 K. The presence of quasi-particles, long-range entanglement, and topological order makes QSLs a promising material platform for building inherently fault-tolerant devices for the storage and processing of quantum information. Several recent reports have proposed schemes to test and leverage these unique properties of QSLs, the majority of which involve thermal transport measurements, considering the electrically inactive nature of QSLs. However, realizing such device schemes demands unconventional approaches to nanofabricate and integrate QSL materials into test structures that can reliably operate under cryogenic temperatures (< 2 K) and large magnetic fields (~ 8 T). In this presentation, I will discuss our recent progress in developing a mesoscale thermal transport measurement platform for testing QSLs that can operate under such constraints. I will describe our efforts towards developing ultrasensitive on-chip cryogenic thermal sensors, fabricating suspended nanostructures with minimal thermal leakage, and successfully integrating 2D QSL materials. The development of this platform enables the measurement and control of mesoscale local temperature gradients in QSLs with sub-mK precision, paving the way for further exploration of their fascinating properties and potential applications in quantum technology.

Topical Area

Hard matter: quantum, electronic, semiconducting materials

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