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Computing with Entanglement: A New Chapter in Quantum Materials

Quantum mechanics describes the physical world around us with exquisite precision, with no known violations of the theory. Its signatures were first observed in atoms and the light they emitted – the revolution in quantum materials has brought to light exotic effects in pristine solids where coherence is preserved. As we now enter the era of quantum computing, materials where coherence can both be preserved and controlled at the nanoscale is needed to harness the potential of entanglement. Materials research thus has a critical role to play in the perfection of conventional materials to elevate quantum entanglement to a robust engineering resource, and to develop new modalities of storing and processing quantum information. Contemporary research directions and emerging developments at the intersection of materials science and information technology will be highlighted.

Irfan Siddiqi is a Professor of Physics and Electrical Engineering & Computer Science at the University of California, Berkeley. He also holds a faculty scientist position at Lawrence Berkeley National Laboratory (LBNL). Siddiqi is currently the director of the Quantum Nanoelectronics Laboratory at UC Berkeley and the Advanced Quantum Testbed at LBNL. Siddiqi is known for contributions to the fields of superconducting quantum circuits, including dispersive single-shot readout of superconducting quantum bits, quantum feedback, observation of single quantum trajectories, and near-quantum limited microwave frequency amplification. He was awarded the American Physical Society George E. Valley Jr. Prize in 2006 "for the development of the Josephson bifurcation amplifier for ultra-sensitive measurements at the quantum limit" and the 2021 John F. Keithley Award for Advances in Measurement Science. Siddiqi is a fellow of the American Physical Society and a recipient of the UC Berkeley Distinguished Teaching Award in 2016, the institution's highest honor for teaching and commitment to pedagogy.

