The Dawn of Superconducting Quantum Processors

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Quantum coherence can now be observed for longer than 100 microseconds in superconducting chips containing tens of physical qubits comprised of Josephson tunnel junctions embedded in resonant microwave circuitry. Such advances leverage advanced fabrication techniques which mitigate surface, interfacial, and radiative losses which are naturally introduced when processing bulk superconducting materials into patterned devices. Combining long-lived coherence with quantum-noise-limited, broadband detection of weak microwave signals has enabled the realization of nascent quantum processors suitable for executing shallow-circuit quantum algorithms with modest gate counts and minimal error mitigation. As an example, I will describe the implementation of a hybrid quantum-classical variational eigensolver with superconducting transmon qubits to determine the ground and excited states of simple molecules with near-chemical accuracy. I will also discuss plans for scaling to larger numbers of qubits, particularly focusing on the growth and suppression of different types of errors.