Building quantum materials with superconducting circuits

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Superconducting artificial atoms are created by connecting Josephson junctions to simple electrical circuits. Individual artificial atoms can be coupled using this same toolbox of inductors, capacitors, and Josephson junctions to build novel quantum materials. In this talk, I will discuss prospects for using the fluxonium artificial atom as a building block for a quantum simulator. The fluxonium qubit is particularly suited to quantum simulation because its energy spectrum is strongly anharmonic and tunable with applied external flux. I will describe a gradiometric circuit based on the fluxonium qubit; this circuit is the smallest building block for realizing a $\sigma_z\sigma_z$-type interaction between fluxonium qubits. We find excellent agreement between the measured spectroscopy of the circuit and the theoretically-predicted level transitions. I will conclude with a proposal for coupling fluxonium qubits in a 1-dimensional array, which can be mapped to an Ising chain with multiple quantum phase transitions.