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Transmon-based simulator of nonlocal electron-phonon coupling: a platform for observing sharp small-polaron transitions[1] VLADIMIR STOJANOVIC, EUGENE DEMLER, Harvard University, MIHAJLO VANEVIC, University of Belgrade, Serbia, LIN TIAN, University of California, Merced — We propose an analog simulator for a one-dimensional model with momentum-dependent (nonlocal) electron-phonon couplings of Su-Schrieffer-Heeger and "breathing-mode" types. The superconducting circuit behind this simulator entails an array of transmon qubits and microwave resonators. Using a microwave-driving based protocol, small-polaron Bloch states with arbitrary quasimomentum can be prepared in this system within times several orders of magnitude shorter than the qubit decoherence time. We show that – by varying the circuit parameters – one can readily reach the critical coupling strength for observing the sharp transition from a nondegenerate single-particle ground state at zero quasimomentum ($K_{\rm gs} = 0$) to a twofold degenerate small-polaron ground state corresponding to equal and opposite (nonzero) quasimomenta $K_{\rm gs}$ and $-K_{\rm gs}$. Through exact diagonalization of our effective model, we show how this nonanalyticity is reflected in the relevant single-particle properties (ground-state energy, quasiparticle residue, average number of phonons). Our work paves the way for understanding the physical implications of strongly momentum-dependent electron-phonon interactions.

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Vladimir M. Stojanovic
Harvard University

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