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Atomic physics and quantum optics using circuits: An overview of recent results on superconducting qubits¹

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Superconducting (SC) circuits can behave like atoms making transitions between a few energy levels. Such circuits can test quantum mechanics at macroscopic scales and be used to conduct atomic-physics experiments on a silicon chip. This presentation overviews a few of our theoretical studies on SC circuits and quantum information processing including: SC qubits for photon generation and for lasing; 2-1 photon coexistence; cooling qubits and their environment; using SC qubits to probe nearby defects; hybrid circuits involving both charge and flux qubits; quantum tomography in SC circuits; preparation of macroscopic quantum superposition states of a cavity field via coupling to a SC qubit; generation of nonclassical photon states using a SC qubit in a microcavity; cluster states; using these circuits as quantum analog emulators of Kitaev lattices; controllable scattering of photons inside a one-dimensional resonator waveguide; and controllable couplings among qubits.

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²The PDF files of our publications are available online at: <http://dml.riken.jp> and also at: <http://www.umich.edu/~nori/>