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Nanomechanical quantum many-body phonon-qubit systems for quantum simulators ONEY SOYKAL, Naval Research Laboratory, Washington DC, CHARLES TAHAN, Laboratory for Physical Sciences, College Park MD — We investigate nanomechanical systems consisting of arrays of coupled phonon cavities each including an impurity qubit in silicon. These experimentally feasible architectures can exhibit quantum many-body phase transitions, e.g. Mott insulator and superfluid states, due to a strong phonon-phonon interaction, and are suitable in the pursuit of quantum simulators. We investigate driven dissipative non-equilibrium systems at zero and non-zero temperatures. These quantum many-body phonon systems can be implemented using either on-chip nano mechanical systems in silicon or DBR heterostructures in silicon-germanium. We examine the experimental procedures to detect these states and show that temperature and driving field (write/read-out) play a critical role in achieving these phonon superfluid and insulator states. These many-body cavity phonon/qubit systems with strong phonon-phonon interactions can be used in forming truly quantum many-body mechanical states for quantum simulators as well as to complement other nano/optomechanical systems.

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