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Superconducting Qubit (transmon) coupled to Surface Acoustic Waves (SAWs)[1] LINGZHEN GUO, GÖRAN JOHANSSON, Department of Microtechnology and Nanoscience (MC2), Chalmers University of Technology, SE-41296 Gteborg, Sweden — We work on a hybrid system, which couples the transmon in circuit QED to the propagating mechanical modes of Surface Acoustic Waves (SAWs). This is an analogue of circuit QED system but replacing the microwave photons by SAW phonons. We investigate the quantum dynamics of a single transmon qubit coupled to surface acoustic waves (SAWs) via two distant connection points. Since the acoustic speed is five orders of magnitude slower than the speed of light, the travelling time between the two connection points needs to be taken into account. Therefore, we treat the transmon qubit as a giant atom with a deterministic time delay. We find that the spontaneous emission of the system, formed by the giant atom and the SAWs between its connection points, initially follows a polynomial decay law instead of an exponential one, as would be the case for a small atom. We obtain exact analytical results for the scattering properties of the giant atom up to two-phonon processes by using a diagrammatic approach. The time delay gives rise to novel features in the reflection, transmission, power spectra, and second-order correlation functions of the system. We show that the giant atom can generate entangled phonon pairs, which may have applications in quantum communication.

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