Abstract Submitted
for the DAMOP17 Meeting of
The American Physical Society

**The giant acoustic atom – a single quantum system with a deterministic time delay**[1] LINGZHEN GUO, Karlsruher Institut fr Technologie(KIT), Germany, ARNE GRIMSMO, Université de Sherbrooke, Canada, ANTON FRISK KOCKUM, Center for Emergent Matter Science, RIKEN, Japan, MIKHAIL PLETYUKHOV, RWTH Aachen University, Germany, GÖRAN JOHANSSON, Chalmers University of Technology, Sweden — 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. Furthermore, we find the short-time dynamics of the giant atom for arbitrary drive strength by a numerically exact method for open quantum systems with a finite-time-delay feedback loop.

[1]L. G. acknowledges financial support from Carl-Zeiss Stiftung (0563-2.8/508/2).

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Date submitted: 17 Jan 2017 Electronic form version 1.4