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Convergent expressions for Purcell rate and Lamb shift of superconducting qubit in an open multimode resonator ALEXANDRU PETRESCU, MOEIN MALEKAKHLAGH, HAKAN TURECI, Princeton Univ — The accurate calculation of the Purcell decay rate and the Lamb shift of an atom in an open multimode environment is a long-standing problem. This problem attained a more immediate and practical significance with the advent of quantum information processing with superconducting quantum circuits. It is now recognized that any attempt at the more accurate calculation of circuit QED quantities gives rise to divergent results [1,2] unless high frequency cutoffs are introduced. We resolve this problem by presenting convergent expressions for the Lamb shift and Purcell decay rate of a superconducting qubit coupled to an open multimode resonator. Our calculation is based on a formulation of sub-gap superconducting quantum electrodynamics using a Heisenberg-Langevin approach [3]. [1] A. A. Houck *et al.*, Phys. Rev. Lett. **101**, 080502 (2008). [2] S. Filipp, *et al.*, Phys. Rev. A **83**, 063827 (2011). [3] Moein Malekakhlagh, Alexandru Petrescu, Hakan E. Türeci, arXiv:1609.00359

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