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ORIGIN AND IMPLICATIONS OF A^2 -LIKE CONTRIBUTION IN THE QUANTIZATION OF CIRCUIT-QED SYSTEMS MOHAMMAD MOEIN MALEKAKHLAGH, HAKAN TURECI, Princeton Univ — It is known that the electromagnetic modal structure of a cavity is modified by placing an atom into it. In cavity QED, this phenomenon manifests itself through the appearance of the A^2-contribution, a gauge-dependent diamagnetic term. Despite the negligible effect in the case of atomic cavity QED systems, in recent superconducting circuit realizations [1] these corrections may be observable and have qualitative implications. In this talk [2], we revisit the canonical quantization of a circuit QED system consisting of a single superconducting transmon qubit coupled to a multimode superconducting microwave resonator. We introduce a new set of modes that properly satisfies current conservation in the entire circuit and discuss how in terms of this set of modes, light-matter coupling can deviate drastically from the previous theories in the literature. Finally, we present a sum rule for the dipole transition matrix elements of a multi-level transmon qubit which provides an upper bound for the possible light-matter coupling strengths. [1] Neereja M. Sundaresan, Yanbing Liu, Darius Sadri, Laszlo J. Szocs, Devin L. Underwood, Moein Malekakhlagh, Hakan E. Tureci, Andrew A. Houck, Phys. Rev. X 5, 021035 [2] Moein Malekakhlagh and Hakan E. Tureci, arXiv:1506.02773 (2015)

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