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Quantum optics in a high impedance environment JAVIER PUERTAS, NICOLAS GHEERAERT, YURIY KRUPKO, REMY DASSONNEVILLE, LUCA PLANAT, FARSHAD FOROUGHUI, CECILE NAUD, WIEBKE GUICHARD, OLIVIER BUISSON, SERGE FLORENS, NICOLAS ROCH, University Grenoble Alpes, CNRS, Institut Neel, F-38000 Grenoble, France, IZAK SNYMAN, Mandlestam Institute for Theoretical Physics, School of Physics, University of the Witwatersrand, Wits 2050, South Africa — Understanding light matter interaction remains a key topic in fundamental physics. Its strength is imposed by the fine structure constant, α. For most atomic and molecular systems $\alpha = \frac{e^2}{\hbar c 4\pi\epsilon_o} \simeq 1/137 \ll 1$, giving weak interactions. When dealing with superconducting artificial atoms, α is either proportional to $1/Z_c$ (magnetic coupling) or Z_c (electric coupling), where Z_c is the characteristic impedance of the environment [1]. Recent experiments [2,3] followed the first approach, coupling a flux qubit to a low impedance environment, demonstrating strong interaction ($\alpha \sim 1$). In our work, we reached the large α regime, following a complementary approach: we couple electrically a transmon qubit to an array of 5000 SQUIDs. This metamaterial provides high characteristic impedance ($\sim 3k\Omega$), in-situ flux tunability and full control over its dispersion relation. In this new regime, all usual approximations break down and new phenomena such as frequency conversion at the single photon level are expected.
[1] Devoret, M. et al. Ann. Phys. (2007) [2] Yoshihara, F. et al., Nat. Phys. (2016) [3] Forn Diaz, P. et al., Nat. Phys. (2016)

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