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Resolving Vacuum Fluctuations in an Electrical Circuit by Measuring the Lamb Shift ANDREAS FRAGNER, MARTIN GOPPL, ETH Zurich, ALEXANDRE BLAIS, Universite de Shrebrooke, ANDREAS WALLRAFF, ETH Zurich, ETH QUANTUM DEVICE TEAM — Quantum theory predicts that empty space is not truly empty. Even in the absence of any particles or radiation, in pure vacuum, virtual particles are constantly created and annihilated. In an electromagnetic field, the presence of virtual photons manifests itself as a small renormalization of the energy of a quantum system, known as the Lamb shift. We present an experimental observation of the Lamb shift in a solid-state system. The strong dispersive coupling of a superconducting electronic circuit acting as a quantum bit (qubit) to the vacuum field in a transmission-line resonator leads to measurable Lamb shifts of up to 1.4% of the qubit transition frequency. The qubit is also observed to couple more strongly to the vacuum field than to a single photon inside the cavity, an effect that is explained by taking into account the limited anharmonicity of the higher excited qubit states.

Andreas Wallraff
ETH Zurich

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