

Giuseppe Falci, CNR (SiUCs) - Detecting virtual photons in ultrastrongly coupled superconducting quantum circuits

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Light-matter interaction, and understanding the fundamental physics behind, is essential for emerging quantum technologies. Solid-state devices may explore new regimes where coupling strengths are “ultrastrong”, i.e. comparable to the energies of the subsystems. New exotic phenomena occur the common root of many of them being the fact that the entangled vacuum contains virtual photons. They herald the lack of conservation of the number of excitations which is the witness of ultrastrong coupling breaking the $U(1)$ symmetry.

Despite more than a decade of research, the detection of ground-state virtual photons still awaits demonstration. In this work, we provide a solution for this long-standing problem. Facing the main experimental obstacles, we find a design of an unconventional “light fluxonium”-like superconducting quantum circuit implemented by superinductors and an advanced control protocol of coherent amplification which yields a highly efficient, faithful and selective conversion of virtual photons into real ones. This enables their detection with resources available to present-day quantum technologies.