DIPARTIMENTO DI SCIENZE MATEMATICHE E INFORMATICHE, SCIENZE FISICHE E SCIENZE DELLA TERRA
Dottorato di Ricerca in Fisica

Appunti di Fisica '24

28 febbraio ore 15:00

Aula SBA-T-2A, piano terra edificio SBA, polo Papardo, Unime

Observation of the strong coupling between a single photon and a photon pair in a superconducting circuit

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The realization of strong nonlinear coupling between single photons has been a long-standing goal in quantum optics and quantum information science, promising wide impact applications, such as all optical deterministic quantum logic and single-photon frequency conversion [1]. I will describe a very recent experimental demonstration of the strong coupling between a single photon and a photon pair in a circuit-QED system [2]. This strong nonlinear interaction is realized by introducing a detuned superconducting artificial atom working as an effective coupler between two modes of a superconducting coplanar waveguide resonator, following a quite recent theoretical proposal [2]. Quantum Rabi-like avoided crossing is resolved when tuning the two-photon resonance frequency of the first mode across the single-photon resonance frequency of the second mode. Within this new photonic regime, we observe second harmonic generation for a mean photon number below one. These results represent a key step towards a new regime of quantum nonlinear optics, where individual photons can deterministically and coherently interact with each other in the absence of any stimulating fields.

[1] D. E. Chang, V. Vuletic, and M. D. Lukin, Quantum nonlinear optics—photon by photon, Nat. Photon. 8, 685 (2014).

[2] S.P. Wang, A. Mercurio, A. Ridolfo, Y. Wang, M. Chen, T. Li, F. Nori, S. Savasta, J.Q. You, arXiv preprint arXiv:2401.02738 (2024).

[3] A. F. Kockum, A. Miranowicz, V. Macrì, S. Savasta, and F. Nori, Deterministic quantum nonlinear optics with single atoms and virtual photons, Phys. Rev. A 95, 063849 (2017).