Photon blockades – when nonlinearity matters in quantum optics

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In many applications of quantum technologies based on quantum optics, such as quantum sensing, computing etc., the crucial point is the knowledge about the numbers of generated photons. One of the methods in which control of the photon numbers is achieved is based on the phenomenon known as photon blockade (PB).

Photon blockade is one of the most striking manifestations of quantum nonlinearity in optical systems. It occurs when the presence of a single photon in a nonlinear cavity prevents the transmission or excitation of additional photons, leading to strongly non-classical light statistics. This phenomenon not only illustrates the fundamental role of nonlinearity in quantum optics but also provides a platform for realizing quantum devices such as single-photon sources and quantum logic gates.

We present a nonlinear hybrid system composed of coupled optical and mechanical subsystems, in which blockade phenomena can be observed not only in the individual photonic and phononic modes but also in the cross photon–phonon mode. This hybrid blockade offers a versatile platform for investigating the statistics of bosonic excitations as well as correlated quantum effects.