ULTRASTRONG COUPLING IN CAVITY QED: EXOTIC PHENOMENA AND THEIR SIMULATION

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Recent technological developments have made it increasingly easy to access the non-perturbative regimes of cavity-QED known as ultra or deep strong coupling, where the light-matter coupling becomes comparable to the bare modal frequencies [1]. Here, we present two works that highlight the unusual phenomenology associated to the ultrastrong coupling regime, and show how these effects can be replicated even without reaching these high-values of light-matter coupling.

First, we will discuss how in the non-perturbative light-matter coupling regime, the single-mode Rabi model becomes unphysical, allowing for superluminal signalling. We show that the multi-mode description of the electromagnetic field, necessary to account for light propagation at finite speed, reveals phenomena of fundamental interest on the dynamics of the intracavity electric field, where a free photonic wavefront and a bound state of virtual photons are shown to coexist [2].

Second, we will describe how a number of analogs of well-known nonlinear-optics phenomena that can be realized in the ultrastrong coupling, such as the excitation of two atoms by a single photon, can also be simulated with coupling rates below this regime by means of strong optical drivings [3].

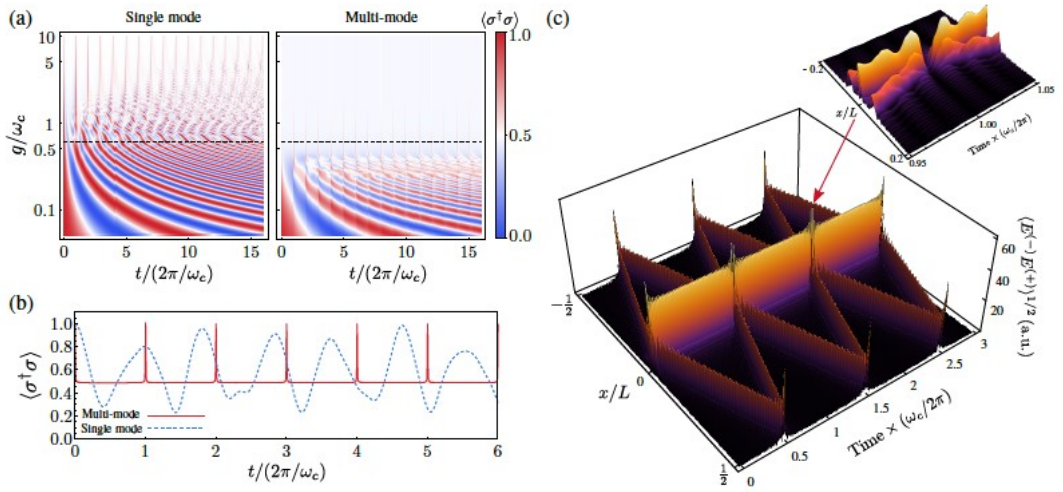

Fig. 1. Dynamics of light and matter in the ultrastrong coupling regime of the multi-mode Rabi model.

References

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