Coherent cavity networks with complete connectivity

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Here we model the electromagnetic field inside an optical cavity using the same notion of photons as in linear optics scattering theory [1]. The normal modes of the proposed cavity Hamiltonian correspond to standing wave photons of frequency omega but with energies that are in general different from hbar omega due to the effect of the mirrors on the systems dynamics. The parameters in the corresponding master equation can be chosen such that they yield the same predictions as Maxwell's equations, when both theories apply. Moreover, our model predicts the same time evolution of the total cavity photon number as the standard quantum optics standing-wave description in experiments with resonant and near-resonant laser driving. Our approach makes it easy to analyse the spontaneous emission of photons through the different sides of an optical resonator and to design coherent cavity networks with complete connectivity. These have potential applications in quantum computing and the simulation of complex interaction Hamiltonians of biological systems [2].

[1] T. M. Barlow and A. Beige, Scattering light through a two-sided optical cavity, arXiv:1307.3545 (2013).

[2] E. S. Kyoseva, A. Beige, and L. C. Kwek, New J. Phys. 14, 023023 (2012).