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Recent theoretical advances on superradiant phase transitions ALEXANDRE BAKSIC, PIERRE NATAF, CRISTIANO CIUTI, Laboratoire MPQ, Université Paris Diderot-Paris 7 and CNRS — The Dicke model describing a single-mode boson field coupled to two-level systems is an important paradigm in quantum optics. In particular, the physics of "superradiant phase transitions" in the ultrastrong coupling regime is the subject of a vigorous research activity in both cavity and circuit QED. Recently, we explored the rich physics of two interesting generalizations of the Dicke model: (i) A model describing the coupling of a boson mode to two independent chains A and B of two-level systems [1], where chain A is coupled to one quadrature of the boson field and chain B to the orthogonal quadrature. This original model leads to a quantum phase transition with a double symmetry breaking and a fourfold ground state degeneracy. (ii) A generalized Dicke model with three-level systems [2,3] including the diamagnetic term. In contrast to the case of two-level atoms for which no-go theorems exist, in the case of three-level system we prove that the Thomas-Reich-Kuhn sum rule does not always prevent a superradiant phase transition.

[1] P. Nataf, A. Baksic and C. Ciuti, Phys. Rev. A **86**, 013832 (2012).
[2] C. Ciuti and P. Nataf, Phys. Rev. Lett. **109**, 179301 (2012).
[3] A. Baksic, P. Nataf, and C. Ciuti, arXiv:1206.3213 (2012).

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