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Photons as phonons: Flexible crystals of atoms and light in multimode cavities SARANG GOPALAKRISHNAN, D. ZEB ROCKLIN, BENJAMIN LEV, PAUL GOLDBART, University of Illinois at Urbana-Champaign — Condensed-matter phenomena involving the emergence and dynamics of crystal lattices can be realized using ultracold atoms confined in multimode optical cavities [1]. The atoms locally crystallize at the antinodes of one of the cavity modes, provided the cavity is transversely pumped by a laser of sufficient intensity. The mode into which the atoms crystallize is likely to vary across the cavity, giving rise to dynamical dislocations, frustration, and possibly glassiness. The crystallization transition is a nonequilibrium quantum phase transition, involving a condensation of cavity photons that is analogous to the condensation of phonons during crystallization in solids. This photon-phonon analogy goes further: the dynamics of atoms in multimode cavities is governed by polaron-like dissipative effects. We discuss various possible kinds of quantum ordering in atom-cavity settings, their imprint on the light emitted from the cavity, and prospects for their experimental realization. [1] S. Gopalakrishnan, B.L. Lev, and P.M. Goldbart, Nature Physics 5, 845-850 (2009).

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