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Novel structures and phase transitions in a superradiant crystal ALEXANDER BAUMGARTNER, DAVIDE DREON, XIANGLIANG LI, PHILIP ZUPANCIC, TILMAN ESSLINGER, TOBIAS DONNER, ETH Zurich — We report on the experimental realization of a superradiant phase transition of a Bose-Einstein Condensate in a high finesse cavity with a repulsive pump-lattice, in which the destructive interference between pump and cavity fields lowers the total energy of the system. Due to lattice symmetries, the band structure plays a key role in this process, and we show that the atoms self-organize in the second band with observable consequences for the phase diagram and the atomic momentum distributions. Furthermore, in this repulsive pump regime, the addition of a running wave transverse pump gives rise to a second type of self-organization phase. We map out the rich phase diagram of the system and identify the phase transition between the two phases as a first-order transition. The dissipated photons out of the cavity lead to real-time access of the dynamics during the phase transition. In our latest experiments we utilize this dissipation channel to couple the two phases and create a dynamic instability as an additional phase.

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