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Collective behavior in the nonequilibrium dynamics of ultracold atoms[1] LIANG-YING CHIH, ATHREYA SHANKAR, JOHN BARTOLOTTA, HAONAN LIU, MURRAY HOLLAND, JILA - Boulder — A common theme of both ultracold quantum gas physics and cavity QED physics is the central role of the collective atomic behavior in the nonequilibrium dynamics. For example, when atoms with ultranarrow linewidth transitions interact with a lossy cavity mode, the resulting collective behavior may lead to exciting emergent phenomena, such as superradiance and spectrally pure light with a frequency that is insensitive to cavity length fluctuations. We investigate a proposed system consisting of a beam of initially excited ultranarrow-linewidth atoms passing through a lossy cavity which promises to be a practical approach to realize a steady-state superradiant laser. In a different physical setup but with similar underlying dynamical equations, we consider the collective effects in the sub-Doppler cooling of hundreds of ions in a Penning trap using a laser cooling method based on electromagnetically induced transparency. Finally, we consider the behavior of a condensated quantum gas driven by a periodic modulation of the two-body scattering length in which we observe the collective dynamics to result in the production of pairs of atoms with high momentum that is equal in magnitude but opposite in direction.

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Liang-Ying Chih
JILA - Boulder

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