Opto-Mechanical Pattern Formation in Cold Atoms

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Transverse pattern formation in an optical cavity containing a cloud of cold two-level atoms is discussed. We show that density modulation becomes the dominant mechanism as the atomic temperature is reduced. Indeed, for low but achievable temperatures the internal degrees of freedom of the atoms can be neglected, and the system is well described by treating them as mobile dielectric particles. A linear stability analysis predicts the instability threshold and the spatial scale of the emergent pattern. Numerical simulations in one and two transverse dimensions confirm the instability and predict honeycomb and hexagonal density structures, respectively, for the blue and red detuned cases.

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