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Optical Pattern Formation in Spatially Bunched Atoms: A Self-Consistent Model and Experiment[1] BONNIE L. SCHMITTBERGER, DANIEL J. GAUTHIER, Duke University Physics Dept. and Fitzpatrick Institute for Photonics — The nonlinear optics and optomechanical physics communities use different theoretical models to describe how optical fields interact with a sample of atoms. There does not yet exist a model that is valid for finite atomic temperatures but that also produces the zero temperature results that are generally assumed in optomechanical systems. We present a self-consistent model that is valid for all atomic temperatures and accounts for the back-action of the atoms on the optical fields. Our model provides new insights into the competing effects of the bunching-induced nonlinearity and the saturable nonlinearity. We show that it is crucial to keep the fifth and seventh-order nonlinearities that arise when there exists atomic bunching, even at very low optical field intensities. We go on to apply this model to the results of our experimental system where we observe spontaneous, multimode, transverse optical pattern formation at ultra-low light levels. We show that our model accurately predicts our experimentally observed threshold for optical pattern formation, which is the lowest threshold ever reported for pattern formation.

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