Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Pattern formation in the synchronization dynamics of arrays of optomechanical oscillators STEVEN HABRAKEN, ROLAND LAUTER, CHRISTIAN BRENDEL, MAX LUDWIG, FLORIAN MARQUARDT, Institute for Theoretical Physics, University of Erlangen-Nuremberg, Germany — We consider two-dimensional arrays of coupled optomechanical cells, each of which consists of a laser-driven optical cavity interacting with a mechanical (vibrational) mode. The mechanical modes can be driven in self-sustained oscillations. We study the collective classical non-linear dynamics of the phases of these oscillations, which is described by the well-studied Kuramoto model and optomechanical extensions thereof [1]. The model parameters can be tuned by the laser drives. We focus on pattern formation and find that, depending on the parameters, the phases may or may not synchronize in a stationary configuration of vortex-antivortex pairs. We identify a relevant length scale and find hysteresis associated to the synchronization transition. For some model parameters, this length scale becomes comparable to the lattice spacing, in which case the phase configurations develop structure on smaller and smaller scales and eventually settle into random patterns. Besides, we address the stability and time evolution of binary patterns in which all oscillators are initialized to phases of 0 or π.

[1] G. Heinrich, M. Ludwig, J. Qian, B. Kubala and F. Marquardt, Phys. Rev. Lett. 107, 043603 (2011).

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Date submitted: 15 Nov 2013 Electronic form version 1.4