Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Geometry and mechanics of growing bacterial colonies. ZHIHONG YOU, DANIEL PEARCE, Univ of Leiden, ANUPAM SENGUPTA, ETH Zurich, LUCA GIOMI, Univ of Leiden — Bacterial colonies are abundant on living and non-living surfaces, and are known to mediate a broad range of processes in ecology, medicine and industry. Although extensively researched from single cells up to the population levels a comprehensive biophysical picture, highlighting the cell-to-colony dynamics, is still lacking. Here, using numerical and analytical models, we study the mechanics of self-organization leading to the colony morphology of cells growing on a substrate with free boundary. We consider hard rods to mimic the growth of rod-shaped non-motile cells, and show that the colony, as a whole, does not form an ordered nematic phase, nor does it result in a purely disordered (isotropic) phase. Instead, different sizes of domains, in which cells are highly aligned at specific orientations, are found. The distribution of the domain sizes follows an exponential relation indicating the existence of a characteristic length scale that determines the domain size relative to that of the colony. A continuum theory, based on the hydrodynamics of liquid crystals, is built to account for these phenomena, and is applied to describe the buckling transition from a planar to three-dimensional (3D) colony. The theory supports preliminary experiments conducted with different strains of rod shaped bacterial cells, and reveals that the buckling transition can be regulated by varying the cell stiffness and aspect ratio. This work proposes that, in addition to biochemical pathways, the spatio-temporal organization in microbial colonies is significantly tuned by the biomechanical and geometric properties of the microbes in consideration.

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Date submitted: 11 Jan 2016 Electronic form version 1.4