Noise-stabilized Turing Patterns in a Synthetic Biofilm

K. MICHAEL MARTINI, Department of Physics and Institute for Genomic Biology, University of Illinois at Urbana-Champaign, DAVID KARIG, Research and Exploratory Development Department, Johns Hopkins University Applied Physics Laboratory, TING LU, Department of Bioengineering, Department of Physics and Institute for Genomic Biology, University of Illinois at Urbana-Champaign, NIGEL GOLDENFELD, Department of Physics and Institute for Genomic Biology, University of Illinois at Urbana-Champaign, RON WEISS, Department of Biological Engineering, Massachusetts Institute of Technology — Deterministic Turing instabilities have been proposed to be a major source of pattern formation in biology, but have been hard to document rigorously, in part because of the requirement for a large ratio of the inhibitor to activator diffusion coefficient. A recently developed theory of stochastic Turing patterns predicts that stochastic or noise-stabilized Turing patterns occur over a larger region of parameter space and do not require as large a separation of diffusion rates. We apply this theory to a biofilm whose signaling molecules have been forward-engineered to exhibit activation and inhibition. Outside of the range of deterministic Turing patterns, we observe noise-stabilized patterns that exhibit a power spectrum power law tail with exponent $-2.3 \pm .4$ consistent with theory. Our results are the first report of a spatial pattern in gene expression stabilized by copy number fluctuations.

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