Stripe formation in an expanding bacterial colony with density-suppressed motility

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Pattern formation is a fundamental process in embryogenesis and development. In his seminal paper half a century ago, Turing proposed a mechanism for spontaneous patte rn formation in biological systems that involve the diffusion of two types of morphog ens (“activator” and “inhibitor”) whose interaction stimulates their own synthesis. Start ing from random initial perturbations, the Turing model typically generates patterns vi a the development of finite-wavelength dynamical instabilities in confined geometries. Recently, a collaboration led by Terry Hwa at UCSD and Jiandong Huang at HKU c onducted experiments of pattern formation in open geometry through control of the sy nthetic chemotactic circuit of bacteria[1]. The growth process can be modeled quantita tively via Fisher-Kolmogorov type equations that exhibit traveling wave solutions. A k ey feature of the current model is a concentration-dependent diffusivity of the active s pecies which can be tuned in the experiment through control of gene expression. The oretical analysis of the traveling wave solution reveals key parameters that span the p hase diagram of the system[2]. Factors controlling more subtle features of the growth pattern, such as the wavelength of the stripes, can also be identified in refined math ematical analysis. The autonomous diffusion control together with the open, expanding geometries offered by growing biological systems, give rise to novel strategies to ge nerate well-defined patterns in space and time.

[1] Chenli Liu et al., Science **334**, 238 (2011).
[2] Xiongfei Fu et al., Phys. Rev. Lett. **108**, 198102 (2012).