## Sequential pattern formation as a front instability problem

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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 pattern formation in biological systems that involve the diffusion of two types of morphogens ("activator" and "inhibitor") whose interaction stimulates their own synthesis. Starting from random initial perturbations, the Turing model typically generates patterns via the development of finite-wavelength dynamical instabilities in confined geometries. Recently, a collaboration led by Terry Hwa at UCSD and Jiandong Huang at HKU conducted experiments of pattern formation in open geometry through control of the synthetic chemotactic circuit of bacteria[1]. A key feature of the system is a concentration-dependent diffusivity of the active species which can be tuned in the experiment through control of gene expression. Theoretical analysis of the traveling wave solution reveals key parameters that span the phase diagram of the system[2]. Very recently, we carried out linear stability analysis of the traveling wave which yields a localized mode. Depending on the sharpness of the motility variation in space, either a Hopf bifurcation or a first order transition to a pulsating front solution can be observed[3]. The autonomous diffusion control together with the open, expanding geometries offered by growing biological systems, give rise to novel strategies to generate well-defined patterns in space and time.

References

1. Chenli Liu *et al*., Science 334, 238 (2011).
2. Xiongfei Fu *et al*., Phys. Rev. Lett. 108, 198102 (2012).
3. Moritz Zehl, Min Tang and Lei-Han Tang, in preparation.