Growth-induced self-organization in bacterial colonies

You, Z.

Author: You, Z.
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Propositions

accompanying the thesis

Growth-Induced Self-Organization in Bacterial Colonies

I. Activity in biological system, e.g. cell growth and cell-cell communication, when entangled with physical properties such as symmetry or anisotropy, can give rise to a whole new class of emergent phenomena that have no analog in nonliving systems.

[Chapter 3 and chapter 4 of this thesis]

II. The shape anisotropy of bacteria contributes significantly to the stress regulation in growing bacterial colonies. This may have provided an evolutionary pressure favoring anisotropic shapes among prokaryotes.

[Chapter 3 and chapter 4 of this thesis]

III. The intelligence displayed in biological systems does not necessarily originate from conscious impulses, but could rather emerge from certain simple physical/biochemical interactions.

[Chapter 4 of this thesis]

IV. The mono-to-multilayer transition in growing bacterial colonies is both deterministic and stochastic.

[Chapter 5 of this thesis]

V. To generalize the discovery that Marinari *et al*. put forward, the role of physics, more specifically mechanics and statistical mechanics, in biological processes, should be taken into consideration seriously.

[E. Marinari *et al*., Nature **484**, 542–545 (2012)]

VI. The results of Wioland *et al.* indicate that the boundary condition, as well as other external stimuli, can significantly alter the dynamics/behaviors of biological systems, and can even change their material properties. This provides a potential route to design smart, controllable materials.

[H. Wioland *et al.*, New J. Phys. **18**, 075002 (2016)]

VII. The work by R. Hartmann *et al.* implies that the extra-cellular matrix has sophisticated mechanical and biological effects on biofilm, hence should be taken into account implicitly or explicitly.

[R. Hartmann *et al.*, Nat. Phys. **15**, 251–256 (2019)]

VIII. The use of analogy, as put forward by Moshe *et al.*, is a powerful tool to cope with the enormous complexity displayed in soft matter systems.

[M. Moshe *et al.*, Phys. Rev. Lett. **122**, 048001 (2019)]

IX. It is between order and chaos that life can find a way.

Zhihong You
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Leiden