This is life: some thoughts on self-organized structure formation in active liquids and biological systems

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Stellingen

behorende bij het proefschrift

This Is Life: Some Thoughts on Self-organized Structure Formation in Active Liquids and Biological Systems

1. Topological defects act as organizing centers for systems described by the Toner-Tu equations. They form the vertices of domain-wall networks and are crucial in driving the transition of the system from an initially completely disordered state into a perfectly ordered one.

   Chapter 2

2. The presence of chiral active stresses can significantly modify the classical results on active defect motion and spontaneous flow transition. The predictions are readily experimentally testable.

   Chapter 3

3. How do complex biological structures emerge during embryonic development from such seemingly uncoordinated building blocks as cells and tissues, and with only minimal environmental guidance? Unifying descriptions, independent of microscopic details of a specific organism, are rare. However, in recent years hydrodynamics has successfully been applied to describe certain types of living systems. Topological defects could play a fundamental guiding role in morphogenesis.

   Chapters 5 and 6

4. If a liquid crystal is coupled to an elastic surface, the surface can become unstable to buckling. The presence of activity either favors or inhibits buckling based on the sign of activity. Both the topology and the geometry of the ground state of the elastic surface have large effects on the (dynamical) states that are accessible.

   Chapters 5 and 6

5. There is some evidence that topological defects might be used by nature as organizing centers to create shapes, for example during the growth of an embryo. However, so far experiments have merely been able to show correlations between topological defects and shape deformations.

   Y. Maroudas-Sacks et al. Nat. Phys. 17, 251 (2021).
   P. Guillamat et al. Nat. Mater. 21, 588 (2022).

6. Just as topological defects seem to play the role of organizing centers in nature, their inherent stability can be used to control active matter systems artificially. While so far many active matter systems have merely been observed, in the future they will be used and applied in a controlled fashion.

   S. Shankar et al. Nat. Rev. Phys. 4, 380 (2022)

7. The inherent chirality of some kinds of cells can result in tissue-wide left-right symmetry breaking, which has been experimentally observed by Yashunsky et al. Further theoretical and experimental investigations are needed to investigate if tissues utilize chirality for directed motion.

   V. Yashunsky et al. Phys. Rev. X 12, 041017 (2022).

8. More experiments on biological systems are needed to measure the hydrodynamic parameters used in the theoretical models, for example activity or surface tension, and to compare theory and experiments quantitatively.

   J. Colen et al. Proc. Natl. Acad. Sci. U.S.A. 118, e2016708118 (2021)

9. Leiden University, and The Netherlands in general, should spend more resources on investigating their colonial history. An effort should be made to publicize the results.

10. The separation between arts, sciences, and humanities is artificial and detrimental. More effort should be put into improving communication between "different" fields.

11. Just because something is scientific, or called science, does not mean that it is good or correct. Not everything needs to be proven by science to be true.

12. Rather than as a passion or uniquely special, academic work should be treated as normal labor.

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