Forces and symmetries in cells and tissues

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Propositions

accompanying the thesis

Forces and Symmetries in Cells and Tissues

1. Properties of tissues are conserved in individual cells, such as cellular traction forces and morphology.

   Chapter 2 of this thesis

2. The Cell-Cell Separation Device pushes the boundaries of technical limitations and enables measurements of intercellular detachment forces of cells with fully developed actin stress fiber network.

   Chapter 3 of this thesis

3. 'Active nematic' descriptions of biological systems need to be extended by 'hexatics'. The hexatic order in epithelial monolayers is dominant, at least at the cellular scale.

   Chapter 4 of this thesis

4. The hexatic symmetry is a faithful readout for intercellular mechanisms. It is controlled by the interplay between cell-cell and cell-matrix adhesion.

   Chapter 5 of this thesis

5. Theoretical concepts about topology and geometry are powerful tools to describe the organization of cells in tissues. With those at hand, we will be able to predict developmental processes in the future.

   Maroudas-Sacks et al., Nat. Phys. 17, 251-259 (2020).
   Matz et al., Development 149, dev201024 (2022).

6. The unjamming transition is described by a competition between cell-cell adhesion and cortical tension. However, variables such as forces at the cell-cell adhesion interface and traction forces exerted on substrates are often overlooked in this context, and may interfere with the current description.

Saraswathibhatla et al., Phys. Rev. X 10, 011016 (2020).
Balasubramaniam et al., Nat. Mater. 20, 1156-1166 (2021).
Vazquez et al., Sci. Rep. 12, 2474 (2022).

7. The solid-to-fluid transition describes the state of the tissue in terms of molecular composition at the cell-cell interface. The hexatic-to-nematic transition, simply described by the symmetry of cells, appears as a more robust alternative description.

Bi et al., Nature Phys. 11, 1074-1079 (2015).
Devany et al., PNAS 118, e1917853118 (2021).

8. '[...] life is defined by biology, not physics.' Science is not black and white. Biological understanding provides the input for physical models, and physical predictions in turn guides biological interpretations.

White et al., Science. 377, 834-839 (2022).

9. The accelerating cycle of academia – strong results enable publications, high-impact publications enable funding, funding enables recruitment of new researchers, and researchers carry out projects and enable new results – is not easily accessible to everyone. This consequently leads to a lack of quality and transparency in research.

10. Global collaborations and knowledge transfer in research are more important than ever. Geopolitical decisions shall never terminate intercultural and peaceful cooperations.

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