TECHNISCHE UNIVERSITÄT DRESDEN

Bereich Mathematik und Naturwissenschaften Fakultät Physik

PHYSIKALISCHES KOLLOQUIUM

Vortrag: **Prof. Dr. Benjamin Friedrich**
Chair for Biological Algorithms
TU Dresden

Thema: **Dynamics in cells and tissues: Synchronization in cilia carpets**
(Antrittsvorlesung)

Zeit und Ort: Dienstag, 30.11.2021, 16:40 Uhr / hybrid in REC C213 (begrenzte Kapazität) und Zoom

A) REC C213 (begrenzte Kapazität – max. 36): Teilnahme nur mit Anmeldung in folgender Dudle-Liste:
https://dudle.inf.tu-dresden.de/PK-Friedrich-30-11
B) Zoom-Meeting: Meeting-ID: 811 1443 7008 / Kenncode: PK-21!-BF
https://tu-dresden.zoom.us/j/81114437008?pwd=bHluNWZreW1SYnR1Z0FkZWVtaXVyQT09

Leitung: Dekan Prof. Dr. Carsten Timm

Kurzfassung:
By definition, living matter is far from thermal equilibrium. It can exhibit rich dynamics, including self-organized pattern formation, but also stochastic dynamics due to small-number fluctuations, all of which have physiological relevance. We are only at the beginning to find theoretical description of these complex systems, which requires suitable coarse-graining and often multi-scale modeling.
After a brief overview of different biological model systems investigated in our group, I will illustrate our research method by highlighting one example of recent work on self-organized synchronization in cilia carpets. Cilia are slender cell appendages powered by molecular motors that can beat like a whip to pump fluids, which propel not only sperm cells and swimming alga, but are also found on epithelial tissues in our airways. There, dense carpets of cilia beat in a coordinated fashion in the form of traveling waves, e.g., to remove pathogens. To study collective dynamics in these systems, we developed a multi-scale modeling approach by extending classical Lagrangian mechanics of dissipative systems to active systems. Applying this framework to cilia carpets allows us derive an effective equation of motion and thus to apply the toolbox of nonlinear dynamics to characterize the emergence of traveling waves and their robustness to perturbations. We find local but not global synchronization, which provides an intriguing link to Statistical Physics and order in two-dimensional spin systems. Last but

not least, local but not global synchronization is also observed experimentally, e.g., in transparent zebrafish as we show in a recent theory-experiment collaboration.

Biographie: Benjamin Friedrich studied mathematics in Leipzig and Cambridge, before he pursued a PhD in Theoretical Biological Physics at the MPI PKS with Frank Jülicher, completed 2009. Afterwards, he was a Koshland post-doctoral fellow with Samuel Safran at the Weizmann Institute in Israel, working on cellular mechanosensing and pattern formation in muscle cells. He returned to the MPI PKS as PKS distinguished fellow, working on problems in biological hydrodynamics and tissue dynamics. In 2016, he became group leader in the Biological Systems path of cfaed. Since 2021, Benjamin Friedrich is a Heisenberg professor (tenure-track) at the Cluster of Excellence 'Physics of Life'.