An active poroelastic model for mechano-chemical Turing patterns in protoplasmic droplets of Physarum polycephalum

Markus Radszuweit [1,2], *Harald Engel* [2], *Markus Bär* [1]
[1]Department for Mathematical Modelling and Data Analysis, Physikalisch Technische Bundesanstalt, Berlin, Germany
[2]Institute of Theoretical Physics, Technische Universität Berlin, Berlin, Germany

We derive and analyze a mechano-chemical model for the contraction patterns observed in protoplasmic droplets of Physarum polycephalum. The mechanical part of this model is obtained from continuum force-balance equations that include the relevant mechanical fields. It combines a calcium oscillator [1] with a model for an active poroelastic two-phase medium, that consists of an active viscoelastic solid modeling the cytoskeleton coupled to a viscous fluid modeling the cytosol [2]. We expand the reaction-diffusion part of the chemical oscillator by advective transport and assume that the active tension in the solid phase is regulated by calcium concentration in the fluid phase at the same location. This provides a mechano-chemical feedback mechanism that gives rise to a Turing-like instability. Two-dimensional finite element/volume simulations (FEM/FVM) of this model reproduce a variety wave patterns, including traveling and standing waves, turbulent patterns and rotating spirals in line with experimental observations of contraction patterns in the protoplasmic droplets.

1. M. Radszuweit, H. Engel and M. Bär, *Eur. Phys. J. Special Topics*, **191**, 159-172 (2010)
2. M. Radszuweit, S. Alonso, H. Engel and M. Bär. *Phys. Rev. Lett.*, **110**, 138102 (2013)