Nonlinear Cross Diffusion Models for Ion Transport through channels

TUE/E3.1
17:00–17:20

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Subject of this talk is the mathematical modelling of ions moving through a membrane channel. Motion can be described in terms of stochastic and partial differential equations. In both cases the treatment of finite size of the particles is of utmost importance.

Ion channels are proteins with a hole down their middle, which regulate the movement of inorganic ions (mainly Na^+, K^+, Cl^- or Ca^{2+}) through the impermeable cell membrane. They are found in all biological membranes of human, plant, animal and bacteria cells and play an important role in diverse processes like nerve and muscle contraction or the regulation of blood pressure.

We introduce an effective model for ionic channels based on stochastic approaches for differently charged particles and derive a system of nonlinear cross diffusion equations. We investigate the transient problem, which is a gradient flow with doubly degenerate diffusivity for an appropriate entropy functional, as well as the stationary system in the case of applied external voltage. We investigate the modified Poisson-Boltzmann equations at equilibrium and introduce modified Slotboom variables, which allow to analyze the linearization around equilibrium and to compute conductances efficiently.

[1] M. WOLFRAM: *Forward and Inverse Solvers for Electro-Diffusion Systems*. PhD thesis 2008.
[2] B. LI: *Continuum electrostatics for ionic solutions with non-uniform ionic sizes*. Nonlinearity, 22, 811-833, 2009.