Oberseminar Nichtlineare Differentialgleichungen

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The gradient-flow structure of non-Newtonian thin-film equations

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ABSTRACT: In this talk, I will offer an insight into the dynamics of thin films of non-Newtonian power-law fluids. In the capillary regime, the height of a thin liquid film on a solid bottom is described by a fourth-order doubly degenerate-parabolic PDE of the form

$$\partial_t u + \partial_x \left(u^n |\partial_x^3 u|^{\alpha-1} \partial_x^3 u \right) = 0. \tag{P}$$

For these power-law fluids, the rheology is described by the flow-behaviour exponent $\alpha > 0$. The starting point of our consideration is that – due to the balance of the viscous dissipation and the rate of change of the surface energy – positive solutions follow a gradient flow w.r.t. the Dirichlet energy. We derive a dissipation potential and use a minimising-movement scheme to demonstrate the gradient-flow structure. In particular, these positive solutions satisfy an energy-dissipation equality.

Using a modified version to guarantee positivity of approximate solutions, we prove existence of global-in-time non-negative weak solutions to (P) satisfying an energy-dissipation inequality for all flow behaviour exponents $\alpha > 0$.

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