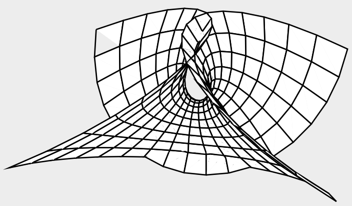

Oberseminar Mathematische Strömungsmechanik

Institut für Mathematik der Julius-Maximilians-Universität Würzburg

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An accurate front capturing scheme for tumor growth models with a free boundary limit

Abstract:

We consider a class of tumor growth models under the combined effects of density-dependent pressure and cell multiplication, with a free boundary model as its singular limit when the pressure-density relationship becomes highly nonlinear. In particular, the constitutive law connecting pressure p and density ρ is $p(\rho) = \frac{m}{m-1}\rho^{m-1}$, and when $m \gg 1$, the cell density ρ may evolve its support due to a pressure-driven geometric motion with sharp interface along the boundary of its support. The nonlinearity and degeneracy in the diffusion bring great challenges in numerical simulations, let alone the capturing of the singular free boundary limit. Prior to the present paper, there is lack of standard mechanism to numerically capture the front propagation speed as $m \gg 1$. In this paper, we develop a numerical scheme based on a novel prediction-correction reformulation that can accurately approximate the front propagation even when the nonlinearity is extremely strong. We show that the semi-discrete scheme naturally connects to the free boundary limit equation as $m \to \infty$, and with proper spacial discretization, the fully discrete scheme has improved stability, preserves positivity, and implements without nonlinear solvers. Finally, extensive numerical examples in both one and two dimensions are provided to verify the claimed properties and showcase good performance in various applications.

Raum 40.03.003 (Mathematikgebäude Ost) | Dienstag, der 13. Aug. 2019 um 13 Uhr

Zu diesem Vortrag sind Sie herzlich eingeladen.

gez. Christian Klingenberg