Matematički modeli u kinetičkoj teoriji polimernih otopina: egzistencija, ekvilibracija i aproksimacija globalnih rješenja

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Predavanje je posvjećeno novom matematičkom rezultatu: dokazu egzistencije i eksponencijalne ekvilibracije globalno slabih rješenja Navier–Stokes–Fokker–Planckovih jednadžbi. Ovi sustavi nelinearnih parcijalnih diferencijalnih jednadžbi potiču iz kinetičke teorije polimernih otopina. Dokaz glavnog teorema bazira se na novoj entropijskoj ocjeni za Fokker–Planckovu jednadžbu u Orliczovoj klasi $\mathrm{L}^1 \log \mathrm{L}^1$.

Fokker–Planckova jednadžba u modelu je parcijalna diferencijalna jednadžba s neglatkim i neograničenim koeficijentima u prostoru visoke dimenzije, i veoma je neprijatna iz aspekta numeričke aproksimacije. Matematički rezultati ilustrirat će se numeričkim simulacijama rješenja Navier–Stokes–Fokker–Planckovih sustava u slučaju trodimenzione Navier–Stokesove jednadžbe i šestodimenzione Fokker–Planckove jednadžbe s takozvanim FENE (Finitely Extensible Nonlinear Elastic) potencijalom.

Predavanje se bazira na seriji zajedničkih radova s John W. Barrett (Imperial College London). Numeričke simulacije rezultat su suradnje s bivšim autorovim doktorantom Davidom Kneževićem (University of Oxford; sada Harvard University).

Mathematical models in the kinetic theory of dilute polymers: existence, equilibration and approximation of global weak solutions

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This lecture is concerned with a new mathematical result: the proof of existence and exponential equilibration of global weak solutions to Navier–Stokes–Fokker–Planck equations. These systems of nonlinear partial differential equations arise from the kinetic theory of dilute polymers. The proof of the main theorem is based on a new entropy estimate for the Fokker–Planck equation in the Orlicz class $\mathrm{L}^1 \log \mathrm{L}^1$.

The Fokker–Planck equation in the model is a partial differential equation with nonsmooth and unbounded coefficients in a high-dimensional space and is quite unpleasant from the point of view of numerical approximation. The mathematical results will be illustrated by numerical simulations of solutions to Navier–Stokes–Fokker–Planck equations in the case of a three-dimensional Navier–Stokes equation and a six-dimensional Fokker–Planck equation with a so-called FENE (Finitely Extensible Nonlinear Elastic) potential.

The lecture is based on a series of joint papers with John W. Barrett (Imperial College London). The numerical simulations are the result of collaboration with my former doctoral student David Knezevic (University of Oxford; now Harvard University).