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DeePN²: A deep learning-based non-Newtonian hydrodynamic model

Lidong Fang, Pei Ge, Lei Zhang, Weinan E, Huan Lei

10.4208/jml.220115

Communicated by: Zhi-Qin John Xu

Category: Application; Algorithm.

Summary for general readers:

Developing reliable physical models for the macro-scale hydrodynamics of non-Newtonian fluids has remained a challenging task for many decades. This study presents a deep learning-based non-Newtonian hydrodynamic model, DeePN², for constructing accurate and interpretable models directly from micro-scale descriptions. Molecular-level fidelity is retained by mapping the polymer configurations into a set of symmetry-preserving macro-scale features. The extended constitutive laws for these macro-scale features, including a new form of the objective tensor derivative, can be directly learned from the kinetics of their micro-scale counterparts. The construction is end-to-end and strictly preserves physical symmetries. It is demonstrated that DeePN² can faithfully capture the broadly overlooked viscoelastic differences arising from the specific molecular structural mechanics without human intervention.

Sponsored by the Center for Machine Learning Research, Peking University & AI for Science Institute, Beijing.

Global Science Press https://www.global-sci.org/jml