An energetic variational approach for wormlike micelle solutions: Coarse graining and dynamic stability

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Wormlike micelles are self-assemblies of polymer chains that can break and recombine reversibly. In this talk, we present a thermodynamically consistent two-species micro-macro model of wormlike micellar solutions by employing an energetic variational approach. The model incorporates a breakage and combination process of polymer chains into the classical micro-macro dumbbell model of polymeric fluids in a unified variational framework. The modeling approach can be applied to other reactive or active complex fluids. Different maximum entropy closure approximations to the new model will be discussed. By imposing a proper dissipation in the coarse-grained level, the closure model, obtained by "closure-then-variation", preserves the thermodynamical structure of both mechanical and chemical parts of the original system. The resulting model is an Oldroyd-B type system coupled with a chemical reaction. We'll also present the dynamic stability analysis on the micro-macro model. In particular, we show the global existence of classical solutions near the global equilibrium, which indicates the consistency between the detailed balance conditions in a chemical reaction and the global equilibrium state of each species. The is joint work with Prof. Chun Liu (IIT) and Prof. Teng-Fei Zhang (CUG).