Thin-film flows of liquid crystals: a consistent model and a numerical method

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The first part of the talk is devoted to a novel hydrodynamical model of liquid crystal films in which three-dimensional Q-tensor states are transported along a closed surface $\Gamma \subset \mathbb{R}^3$ by a tangent flow. A thermodynamically consistent coupling of the momentum equation and the Landau-de Gennes dynamics is derived from the generalized Onsager principle following the Beris-Edwards system.

In the second part we solve numerically the system of geometric PDEs which stems from the new model. Two connected computational problems are solved. On the one hand, we need to work with discrete vector and matrix fields on Γ which are degenerate from the $\mathbb{R}^3$ perspective and thus, a proper stabilization of the finite element spaces is needed. On the other hand, these stabilizations should not affect the energy structure of the geometric PDEs on the discrete level. We prove the preservation of the energy structure for a fully discrete numerical scheme and present some interesting simulations.