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Dynamics of chiral liquid-crystal films driven by water transport[1]
JONATHAN V. SELINGER, LENA M. LOPATINA, Liquid Crystal Institute, Kent State University — In previous experimental and theoretical research, Tabe and Yokoyama investigated Langmuir monolayers of chiral molecules on the surface of water, and found that evaporation of water induces collective precession of the molecular orientation [1]. More recently, they have found a similar effect in freely suspended films of chiral smectic liquid crystals, but with one new feature: the molecular rotation is accompanied by large- scale flow of the molecules, indicating a strong coupling between orientation and flow. To model the coupled rotation and flow driven by water transport, we construct the Lagrangian and Rayleigh dissipation function appropriate for a film in the smectic-A or smectic-C phase, derive the equations of motion, and solve these equations in geometries corresponding to the experiments. In particular, we calculate the flow patterns in terms of the viscosity coefficients of the liquid-crystal films, in order to understand the mechanisms that control this dynamic behavior. The theoretical predictions are compared with experimental results, and with related work on granular materials [2].

[1] Y. Tabe and H. Yokoyama, Nature Mat. 2, 806 (2003).
[2] J.-C. Tsai, F. Ye, J. Rodriguez, J. P. Gollub, and T. C. Lubensky, Phys. Rev. Lett. 94, 214301 (2005).

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