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Capillarity and capillary waves in immiscible two-fluid channel flows
PHILIP YECKO, Dept. of Mathematical Sciences, Montclair State University
— The configuration of two immiscible fluids undergoing sheared Couette-Poiseuille
flow in a straight channel is analyzed as a linearized stability problem, both from
the point of view of eigenvalues and energy growth resulting from the non-normality
of the stability operator. Only mild density contrasts (0.75 < r < 1) are considered
and attention is placed on the dual role of capillarity, namely: the role of capil-
larly modes in the energy growth of disturbances and the role of capillarity in the
generic stability problem. It is found that when the capillary wavevector is normal
to the flow plane, capillarity facilitates the exchange of energy between the mean
and perturbed flows and can significantly affect the nature of growing disturbances.
This is in stark contrast to the more subtle role of capillarity in general, where its
primary effect is dissipative and appears as eigenvalue damping. In addition, calcu-
lations in the eigenvalue subcritical regime indicate the possible existence of steady
deformed interface solutions which may persist, in the nonlinear regime, as steady
finite amplitude states.

Philip Yecko
Montclair State University

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