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Stability of laminar flows in an inclined open channel. (English) [Zbl 07369917]

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Summary: We study the stability of laminar flows in a sheet of fluid (open channel) down an incline with constant slope angle $\beta$. The basic motion is the velocity field $U(z)i$, where $z$ is the coordinate of the axis orthogonal to the channel, and $i$ is the unit vector in the direction of the flow. $U(z)$ is a parabolic function which vanishes at the bottom of the channel and whose derivative with respect to $z$ vanishes at the top.

We study the linear stability, and prove that the basic motion is linearly stable for any Reynolds number. We also study the nonlinear Lyapunov stability by solving the Orr equation for the associated maximum problem. As in [the authors, “Nonlinear stability results for plane Couette and Poiseuille flows”, Phys. Rev. E 100, No. 1, Article ID 013113, 10 p. (2019; doi:10.1103/PhysRevE.100.013113)] we finally study the nonlinear stability of tilted rolls.

This work is a preliminary investigation to model debris flows down an incline [F. V. de Blasio, Introduction to the physics of landslides. Lecture notes on the dynamics of mass wasting. Dordrecht: Springer (2011; doi:10.1007/978-94-007-1122-8)].

MSC:

76E05 Parallel shear flows in hydrodynamic stability
76E30 Nonlinear effects in hydrodynamic stability
76D05 Navier-Stokes equations for incompressible viscous fluids
76M99 Basic methods in fluid mechanics

Keywords:
channel shear flow; Navier-Stokes equations; linear energy stability; Orr equation; nonlinear Lyapunov stability; Chebyshev collocation method

Full Text: DOI

References:


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