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The Hagen-Poiseuille, Plane Couette and Poiseuille Flows Linear Instability and Rogue Waves Excitation Mechanism

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Linear hydrodynamic stability theory for the Hagen-Poiseuille (HP) flow yields a conclusion of infinitely large threshold Reynolds number, Re, value. This contradiction to the observation data is bypassed using assumption of the HP flow instability having hard type and possible for sufficiently high-amplitude disturbances. HP flow disturbance evolution is considered by nonlinear hydrodynamic stability theory. Similar is the case of the plane Couette (PC) flow. For the plane Poiseuille (PP) flow, linear theory just quantitatively does not agree with experimental data defining the threshold Reynolds number Re= 5772 (S. A. Orszag, 1971), more than five-fold exceeding however the value observed, Re=1080 (S. J. Davies, C. M. White, 1928).
In the present work, we show that the linear stability theory conclusions for the HP and PC on stability for any Reynolds number and evidently too high threshold Reynolds number estimate for the PP flow are related with the traditional use of the disturbance representation assuming the possibility of separation of the longitudinal (along the flow direction) variable from the other spatial variables. We show that if to refuse from this traditional form, conclusions on the linear instability for the HP and PC flows may be obtained for finite Reynolds numbers (for the HP flow, for Re>704, and for the PC flow, for Re>139). Also, we fit the linear stability theory conclusion on the PP flow to the experimental data by getting an estimate of the minimal threshold Reynolds number as Re=1040. We also get agreement of the minimal threshold Reynolds number estimate for PC with the experimental data of S. Bottin, et.al., 1997, where the laminar PC flow stability threshold is Re = 150.
Rogue waves excitation mechanism in oppositely directed currents due to the PC flow linear instability is discussed.
Results of the new linear hydrodynamic stability theory for the HP, PP, and PC flows are published in the following papers:

1. S.G. Chefranov, A.G. Chefranov, JETP, v.119, No.2, 331, 2014
2. S.G. Chefranov, A.G. Chefranov, Doklady Physics, vol.60, No.7, 327-332, 2015
3. S.G. Chefranov, A. G. Chefranov, arXiv: 1509.08910v1 [physics.flu-dyn] 29 Sep 2015
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