

Formation and coarsening of roll waves in shear flows down an inclined rectangular channel

K. Ivanova,^{*} S. Gavriluyuk [†] B. Nkonga,[‡] G. Richard[§]

Recently, a new model of shear shallow water flows was developed in Richard & Gavriluyuk (2012, 2013)[1],[2]:

$$\frac{\partial h}{\partial t} + \frac{\partial hU}{\partial x} = 0, \quad (1)$$

$$\frac{\partial hU}{\partial t} + \frac{\partial}{\partial x} \left(hU^2 + \frac{g'h^2}{2} + (\varphi + \Phi)h^3 \right) = \hat{g}h - CU^2, \quad (2)$$

$$\frac{\partial}{\partial t} \left(h \frac{U^2 + g'h + (\varphi + \Phi)h^2}{2} \right) + \frac{\partial}{\partial x} \left(hU \left(\frac{U^2}{2} + g'h + \frac{3}{2}(\varphi + \Phi)h^2 \right) \right) = (\hat{g}h - C_e U^2)U. \quad (3)$$

Here h is the fluid depth, U is the average velocity, $g' = g \cos \theta$, $\hat{g} = g \sin \theta$, θ is the inclination angle, C is the Chézy coefficient, Φ is the enstrophy of large eddies, $C_e = C + C_r \Phi / (\varphi + \Phi)$, where C_r is a new dissipation coefficient, and φ is the enstrophy of small eddies generated near the bottom.

Some numerical results on roll waves formation in a long channel and in a periodic box for a such model are presented using finite volume Godunov scheme with MUSCL-Hancock approach. They are compared with experimental results. The numerical results for the periodic box and a long channel are compared. The effect of wave coarsening is discovered. The stability of roll waves in the periodic box was studied. Some numerical results in the 2D case for a simplified model of shear shallow water flows are also presented.

References

- [1] Gaël L Richard and Sergey L Gavriluyuk. A new model of roll waves: comparison with Brock's experiments. *Journal of Fluid Mechanics*, 698:374–405, 2012.
- [2] Gaël L Richard and Sergey L Gavriluyuk. The classical hydraulic jump in a model of shear shallow-water flows. *Journal of Fluid Mechanics*, 725:492–521, 2013.

^{*}Aix-Marseille Université, C.N.R.S. U.M.R. 7343, IUSTI, 5 rue E. Fermi, 13453 Marseille Cedex 13 France, kseniya.ivanova@univ-amu.fr

[†]Corresponding author, Aix-Marseille Université, C.N.R.S. U.M.R. 7343, IUSTI, 5 rue E. Fermi, 13453 Marseille Cedex 13 France, sergey.gavriluyuk@univ-amu.fr

[‡]Université de Nice Sophia-Antipolis, C.N.R.S. U.M.R. 7351, Laboratoire J.A.Dieudonné, Parc Valrose, 06108 NICE Cedex 2 France, Boniface.Nkonga@unice.fr

[§]Université de Toulouse, C.N.R.S. U.M.R. , Toulouse France, Gael.Richard@math.univ-toulouse.fr