4-Equations Model for Thin liquid Films

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After [1], the use of Weighted Residual Method (WRM) to derive shallow water models for free surfaces has been a true refinement in modeling thin liquid films. An advantage in using WRM is that there is no need to use asymptotic expansions to close the system, and also we have an exact velocity profile which would eventually lead to obtain good results for the relaxation terms compatible with the eigenmodes (damping coefficients) of a perturbed viscous film. On the other hand, in [2], the authors have successfully introduced a new variable equivalent to the enstrophy to derive a consistent shallow water model. In the following approach, we introduce two new variables that express an easier expression for the enstrophy and thus enable an easier extension to 2D models (3D flows). We have tried to derive a refined 4-equation shallow water model using WRM and the velocity profile defined in terms of these two variables which are related to the second moment of the deviation of the shear velocity from its depth average. The obtained model is consistent at first order, and good numerical results are obtained for the second order model when tested for solitary wave solutions. Our derivation is done starting from the incompressible Navier Stokes system for a free surface fluid driven by gravity and flowing down an inclined plane.

Références

[1] RUYER-QUIL C, MANNEVILLE P. Improved modeling of flows down inclined planes. *The European Physical Journal B-Condensed Matter and Complex Systems.*2000 May ;15(2) :357-69.

[2] RICHARD GL, RUYER-QUIL C, VILA JP. A three-equation model for thin films down an inclined plane. *Journal of Fluid Mechanics.* 2016 Oct 10 ;804 :162.

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