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Green-Naghdi type equations for water waves propagating on a vertically uniform shear current

Manna Miguel A. (1), Noubissie Samuel (2), Touboul Julien (3,4), Kraenkel Roberto A. (5), Simon Bruno (3,4)

(1) Université de Montpellier, Laboratoire Charles Coulomb (L2C), Physique Théorique, Montpellier, France (miguel.manna@univ-montp2.fr), (2) University Institute of Technology, University of Dschang, P. O. Box 134 Bandjoun, Cameroon., (3) Université de Toulon, CNRS - INSU, IRD, MIO, UM 110, 83957 La Garde, France, (4) Aix-Marseille Université, CNRS - INSU, IRD, MIO, UM 110, 13284 Marseille, France, (5) Instituto de Fisica Téorica-UNESP, Universidade Estadual Paulista,Rua Dr. Bento Teobaldo Ferraz 271 Bloco II, 01140-070, Sao Paulo, Brazil.

The main objective of our work is to derive higher order Green-Naghdi type equations with vorticity using a generalised linear pattern Anzats as well as both of the two perturbative parameters $\alpha = a/h < 1$ and $\delta = kh < 1$ with h the constant depth of the fluid and a and k a typical amplitude and wavelength of the wave being studied. To do this we proposed a generalisation of Jonhson's method (see R. S. Johnson, J. Fluid. Mech. **455**, 63-62 (2002)) used in order to obtain the classical Green-Naghdi system. Our generalisation is based on two main hypothesis: **A)** an Anzats suggests by an expansion of the horizontal velocity of the fluid in a infinity series in powers of $z^2\delta^2$ (with z the vertical space coordinated) and **B)** the fact that in two dimensions the vorticity $\vec{\omega}$ is conserved i.e.; $D\vec{\omega}/Dt = 0$ (where D/Dt is material derivative). This results in a generalised Green-Naghdi model with vorticity equivalent, *mutatis mutandi*, to a *multi-layer model* in place of the single-layer model. The very important role played by the vorticity is explained. We analyse Green-Naghdi models with nil, normal, weakly and strong vorticity. Solitary solutions for the horizontal fluid velocity $u(x,t)$ and the free surface $\eta(x,t)$ are exhibited and plotted.