PHYSICAL MATHEMATICS SEMINAR

INTRUSIVE GRAVITY CURRENTS IN A STRATIFIED AMBIENT – SHALLOW-WATER THEORY NUMERICAL RESULTS AND NEW INTERPRETATIONS OF PREVIOUS EXPERIMENTS

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ABSTRACT:

The intrusion of a fixed volume of fluid which is released from rest and then propagates horizontally at the neutral buoyancy level in a vertically-stratified ambient fluid is investigated. The density change is linear, in a restricted layer or over the full-depth of the container, and locks of both rectangular and cylindrical shapes are considered. The investigation was motivated by the fact that previous theoretical models ([4, 5, 8]) were in conflict with experimental observations (see [2]). The present theory employs a closed one-layer shallow-water inviscid formulation. The propagation of the intrusion, in realistic configurations, is obtained from the solutions of a hyperbolic well-posed system. A similarity solution for the large-time developed motion, and an approximate box-model are also presented. The results are corroborated by numerical solutions of the full two-dimensional Navier-Stokes equations and comparisons with previously published experiments ([1, 2, 6, 8]). It is shown that the model is a versatile prediction tool which clarifies essential features of the flow-field. Accurate insights are provided concerning: (1) the governing dimensionless parameters; (2) the fact that the initial propagation is with constant speed for intrusions released from a rectangular lock but time-dependent for the cylindrical lock used in Wu's experiments; (3) the spread with time at some power; (4) the sub-critical (compared to the mode 2 linear waves) speed in a full-depth stratified container configuration; and (5) the first interaction of the head with the internal gravity waves. This rehabilitates the validity of the inviscid shallow-water modeling for these problems. It is shown that the previous theoretical models can now be dismissed (with due credit) because the present approach has a much broader range of validity and relevance. Some connections with other recent results and extensions will be briefly discussed.

References

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[4] T. W. Kao. Principal stage of wake collapse in a stratified fluid: Two-dimensional theory. *Phys. Fluids,* 19:1071—1074, 1976.

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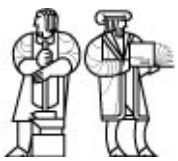
TUESDAY, MARCH 6, 2007
2:30 PM
Building 2, Room 146

Refreshments at 3:30 PM in Building 2, Room 349
(Applied Math Common Room)



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