A Hamiltonian system for internal solitary-wave solutions in a two-layer flow with a top free surface: a critical point analysis

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Abstract:
We revisit the strongly nonlinear long wave model for large amplitude internal waves in two-layer flows with a free surface proposed by Choi & Camassa (1996) and Barros, Gavrilyuk & Teshukov (2007). Its solitary-wave solutions are governed by a Hamiltonian system with two degrees of freedom, whose critical points are examined in detail leading to some new results. In particular, it is shown that conjugate states for the long wave model are the same as those predicted by the fully nonlinear Euler equations. Some emphasis will be given to the baroclinic mode, where interfacial waves are known to change polarity according to different values of density and depth ratios. The analytical expression of the critical depth ratio separating these two regimes is derived directly from the model, and we prove that such waves cannot exist throughout the whole range of speeds within the baroclinic mode.