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Nonlinear modeling of wave-topography interactions, shear instabilities and shear induced wave breaking using vortex method ANIRBAN GUHA, Indian Inst of Tech-Kanpur — Theoretical studies on linear shear instabilities as well as different kinds of wave interactions often use simple velocity and/or density profiles (e.g. constant, piecewise) for obtaining good qualitative and quantitative predictions of the initial disturbances. Moreover, such simple profiles provide a minimal model to obtain a mechanistic understanding of shear instabilities. Here we have extended this minimal paradigm into nonlinear domain using vortex method. Making use of unsteady Bernoulli's equation in presence of linear shear, and extending Birkhoff-Rott equation to multiple interfaces, we have numerically simulated the interaction between multiple fully nonlinear waves. This methodology is quite general, and has allowed us to simulate diverse problems that can be essentially reduced to the minimal system with interacting waves, e.g. spilling and plunging breakers, stratified shear instabilities (Holmboe, Taylor-Caulfield, stratified Rayleigh), jet flows, and even wave-topography interaction problem like Bragg resonance. We found that the minimal models capture key nonlinear features (e.g. wave breaking features like cusp formation and roll-ups) which are observed in experiments and/or extensive simulations with smooth, realistic profiles.

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