Instability of Steep Ocean Waves and Whitecapping

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Wave breaking in deep oceans is a challenge that still defies complete scientific understanding. Sailors know that at wind speeds of approximately 5m/sec, the random looking windblown surface begins to develop patches of white foam ('whitecaps') near sharply angled wave crests. We idealize such a sea locally by a family of close to maximum amplitude Stokes waves and show, using highly accurate simulation algorithms based on a conformal map representation, that perturbed Stokes waves develop the universal feature of an overturning plunging jet. We analyze both the cases when surface tension is absent and present. In the latter case, we show the plunging jet is regularized by capillary waves which rapidly become nonlinear Crapper waves in whose trough pockets whitecaps may be spawned.