Steady Water Waves of Large Amplitude with Stagnation and Eddies

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Consider 2D steady incompressible water waves under the influence of gravity but without surface tension. If such a wave is irrotational, there can be no eddies and no stagnation points (other than at the crest). The structure of such waves can be much richer in the presence of
vorticity. In joint work with Adrian Constantin and Eugen Varvaruca, we consider the simplest vorticity, a constant, which permits the use of conformal mapping to transform the problem to an equation on the free surface involving the finite Hilbert transform. We prove the existence of
waves of large amplitude with rich structure. There can be eddies, overhanging waves and stagnation points.