Novel approach to find stability of 2D water waves

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Abstract

The Stokes wave is a water wave that travels over a free surface of water without changing shape. When a time-varying fluid domain is mapped to a fixed geometry, such as a periodic strip in the lower half-plane, the equation for the Stokes wave is a nonlinear integro-differential ODE whose solutions are found numerically to arbitrary precision. The spectral stability of Stokes waves is studied by linearization of the equations of motion for the free surface around a Stokes wave, and studying the spectrum of the associated Fourier-Floquet-Hill (FFH) eigenvalue problem. We developed a novel approach to studying the eigenvalue spectrum by combining the conformal Hamiltonian canonical variables, the FFH technique built into a matrix-free Krylov-Schur eigenvalue solver. We report new results for the Benjamin-Feir instability as well as the high-frequency, and localized (superharmonic) instabilities of the waves close to the limiting Stokes wave.