

# Obtaining Stokes wave with high-precision using conformal maps and spectral methods on non-uniform grids

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**Abstract:** Two-dimensional potential flow of the ideal incompressible fluid with free surface and infinite depth has a class of solutions called Stokes waves which is fully nonlinear periodic gravity waves propagating with the constant velocity. We developed a new highly efficient method for computation of Stokes waves. The convergence rate of the numerical approximation by a Fourier series is determined by the complex singularity of the travelling wave in the complex plane above the free surface. We study this singularity and use an auxiliary conformal mapping which moves it away from the free surface thus dramatically speeding up Fourier series convergence of the solution. Three options for the auxiliary conformal map are described with their advantages and disadvantages for numerics. Their efficiency is demonstrated for computing Stokes waves near the limiting Stokes wave (the wave of the greatest height) with 100-digit precision. Drastically improved convergence rate significantly expands the family of numerically accessible solutions and allows us to study the oscillatory approach of these solutions to the limiting wave in great detail.

**Speaker**

**Denis  
Sylantiev  
Courant  
Institute**