Abstract View

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On the Nonlinear Theory for Gravity Waves on the Ocean's Surface. Part I: Derivations

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ABSTRACT

A general hydrodynamic solution is derived for arbitrary gravity-wave fields on the ocean surface by extending Stokes' (1847) original perturbational analysis. The solution to the nonlinear equations of motion is made possible by assuming that the surface height is periodic in both space and time and thus can be described by a Fourier series. The assumption of periodicity does not limit the generality of the result because the series can be made to approach an integral representation by taking arbitrarily large fundamental periods with respect to periods of the dominant ocean waves actually present on the surface. The observation areas and times over which this analysis applies are assumed small, however, compared to the periods required for energy exchange processes; hence an "energy balance" (or steady-state) condition is assumed to exist within the observed space-time intervals. This in turn implies the condition of statistical stationarity of the Fourier height coefficients when one generalizes to a random surface. Part I confines itself to the formulation of a perturbation solution (valid to all orders) for the higher order terms resulting from a two-dimensional arbitrary periodic description of the surface height. The method is demonstrated by deriving (to second order) the height correction to the sea and (to third order) the first nonzero correction to the lowest order gravity-wave dispersion relation.

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