



On computing nonlinear wave-wave interactions – open questions and latest developments

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Although great advances have been made over the last five decades in modelling the nonlinear wave-wave interactions, the topic is far from being exhausted. Despite considerable progress, many open questions remain. This paper gives a brief summary of problems in the understanding and modelling of nonlinear wave-wave interactions. Recent developments together with suggestions for further research are also discussed.

The discussion is confined to a few outstanding issues:

(a) Although nonlinear energy transfer can be predicted with rigorous theories such as that of resonant weakly nonlinear interaction between sets of four waves (i.e. the kinetic or Boltzmann equation by Hasselmann) or directly from the hydrodynamic equations based on first principles with no assumptions involved, it is not yet completely clear whether the solutions converge to the same universal solution. Despite a few results available in literature there are still unresolved controversies, discrepancies and challenges that we aim discussing in this paper along with some recent developments.

(b) To date, there is no clear view on the role of near-resonant interactions in the evolution of nonlinear waves. Recent works point out to expectations that near-resonant interactions, rather than the exact resonance, dominate the temporal nonlinear evolution. Even though one can in principle account for near-resonant interaction in the spatio-temporal domain, its practical use in an operational wave prediction model is far from being established. This paper will discuss the latest development within the framework of a novel wave-action transfer model that would cover near-resonant interactions and Stokes corrections, as well as the associated computational challenges and the open questions that must be addressed.

(b) Currently, quite a few exact, quasi-exact and approximate methods exist to compute the nonlinear four-wave interaction. However, usually only one approximate method is in use to compute the non-linear quadruplet wave-wave interactions for a discrete wind wave spectrum usually in third-generation wave prediction models. Up until now no comprehensive and more importantly objective comparison has been performed to determine the best (both in terms of performance and accuracy) method for computing the nonlinear four-wave interactions in a discrete spectral model. A good understanding of these methods is crucial for the interpretation of the results of the numerical aspects. In this paper we outline and discuss the foundation of an inter-comparison study that should provide answers to a range of basic questions as well as provide a systematic analysis of the characteristics of these methods.