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Investigations of coherence in extreme water waves

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We investigated in detail highly nonlinear focusing wave group experiments in the MARIN hydrodynamic laboratory (Maritime Research Institute Netherlands) and also the recorded time signal of the well known Draupner (New Year) wave. For given wave spectrum, we introduce the concept of maximal and pseudo-maximal wave as a measure of the coherence of a signal or its unidirectional evolution in space. These concepts are an alternative for the statistical engineering concept of 'new wave' as investigated in [1].
Using very accurate simulations with the AB model equation [2], we investigated for the wave group properties close to focusing such as the very local and very sudden nonlinear changes of the spectrum, the phases and the symmetry of the evolution. For the Draupner signal (which has wave height of more than 25m in a background of waves of significant wave height of 12 m) we looked at similar properties using the computed forward and backward evolution.
The designed laboratory wave groups are very coherent: at position and time of focusing, all phases are coherent (except for the Stokes long wave set-down); these waves are nearly maximal waves. The Draupner wave, for which the signal turns out to be recorded very close to its maximal wave height, is less coherent but can be described in a good approximation as a pseudo-maximal wave for which the phases are coherent, but has a spectrum that is a scaled version of the original spectrum.

1. D.A.G. Walker, P.H. Taylor and R.E. Taylor, 2004. The Shape of large surface waves on the open sea and the Draupner New Year wave. Applied Ocean Research 26, p. 73-83
2. E. van Groesen and Andonowati, 2007. Variational derivation of KdV-type of models for surface water waves. Physics letters. Section A, 366: p. 195-201