Geophysical Research Abstracts
Vol. 18, EGU2016-3290, 2016
EGU General Assembly 2016

The laboratory investigation of surface envelope solitons: reflection from a vertical wall and collisions of solitons

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Envelope soliton solutions are key elements governing the nonlinear wave dynamics within a simplified theory for unidirectional weakly modulated weakly nonlinear wave groups on the water surface. Within integrable models the solitons preserve their structure in collisions with other waves; they do not disperse and can carry energy infinitively long. Steep and short soliton-like wave groups have been shown to exist in laboratory tests [1] and, even earlier, in numerical simulations [2, 3]. Thus, long-living wave groups may play important role in the dynamics of intense sea waves and wave-structure interactions. The solitary wave groups may change the wave statistics and can be taken into account when developing approaches for the deterministic forecasting of dangerous waves, including so-called rogue waves.

An experimental campaign has been conducted in the wave basin of the Technical University of Berlin on simulations of intense solitary wave groups. The first successful experimental observation of intense envelope solitons took place in this facility [1]. The new experiments aimed at following main goals: 1) to reproduce intense envelope solitons with different carrier wave lengths; 2) to estimate the rate of envelope soliton dissipation; 3) to consider the reflection of envelope solitons on a vertical wall; 4) to consider head-on collisions of envelope solitons, and 5) to consider overtaking interactions of envelope solitons. Up to 9 wave gauges were used in each experimental run, which enabled registration of the surface movement at different distances from the wavemaker, at different locations across the wave flume and near the wall. Besides surface displacements, the group envelope shapes were directly recorded, with use of phase shifts applied to the modulated waves generated by the wavemaker.

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