Geophysical Research Abstracts,
Vol. 10, EGU2008-A-01441, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-01441
EGU General Assembly 2008

Fission of an interfacial solitary wave at a step

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The transformation of the KdV interfacial solitary wave in an ideal two-layer flow over a step is studied. In the vicinity of the step the wave transformation is described in the framework of the linear theory of long interfacial waves, and the coefficients of wave reflection and transmission are calculated. A strong transformation arises for propagation into shallower water, but a weak transformation for propagation into deeper water. Far from the step, the wave dynamics is described by the Korteweg-de Vries equation which is fully integrable. In the vicinity of the step, the reflected and transmitted waves have soliton-like shapes, but their parameters do not satisfy the steady-state soliton solutions. Using the inverse scattering technique it is shown that the reflected wave evolves into a single soliton and dispersing radiation if the wave propagates from deep to shallow water, and only a dispersing radiation if the wave propagates from shallow to deep water. The dynamics of the transmitted wave is more complicated. In particular, if the coefficient of the nonlinear quadratic term in the Korteweg-de Vries equation is not changed in sign in the region after the step, the transmitted wave evolves into a group of solitons and radiation, a process similar to soliton fission for surface gravity waves at a step. But if the coefficient of the nonlinear term changes sign, the soliton destroys completely and transforms into radiation. The effects of cubic nonlinearity are studied in the framework of the extended Korteweg-de Vries (Gardner) equation which is also integrable. The higher-order nonlinear effects influence the amplitudes of the generated solitons if the amplitude of the transformed wave is comparable with the thickness of lower layer, but otherwise the process of soliton fission is qualitatively the same as in the framework of the Korteweg-de Vries equation.