Applications of Soliton Interactions in Rogue Wave Theory and in Understanding the Impact of Vessel Wakes

Tarmo Soomere

Institute of Cybernetics at Tallinn University of Technology
Akadeemia tee 21, 12618 Tallinn
ESTONIA
e-mail: soomere@cs.ioc.ee

ABSTRACT

The idea that an appropriate nonlinear mechanism could be responsible for extreme waves has been employed in many studies. While interaction of unidirectional Korteweg-de Vries solitons does not create any drastic increase of surface elevation, large elevations and slopes of the water surface may occur when the solitons are reflected from a wall or solitons propagating in different directions meet each other. The resulting structures resemble the phenomena occurring during the Mach reflection. Their properties can be described by means of (optionally non-stationary) multi-soliton solutions to the Kadomtsev-Petviashvili (KP) equation.

Although the almost exact balance necessary to produce extreme elevations and slopes occurs seldom, the resulting high humps may persist for a long time until the balance is violated. This mechanism may be a generic source of abnormally high and steep waves in areas of moderate depth.

Evidence of such interactions and their possible consequences in realistic conditions are discussed. In particular, studies into ship waves have led to simple explanations of many essential features of wave dynamics occurring in shallow coastal areas, and to discovery of some effects, smart usage of which may essentially increase shipping safety as well as reduce safety problems caused by fast ferry traffic. Further studies into nonlinear ship waves are therefore of paramount importance, not only because they offer an insight into new forcing factors of the coastal environment in certain areas but mainly because the progress that science, and naval and coastal engineering, as well as society as a whole, can achieve by using them as a small-scale model for studies of otherwise extremely dangerous tsunamis and rogue waves.