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The Dynamics of Ocean Waves

The theory of ocean waves has been an active topic of research for more than 150 years due to the significance of the sea in human history. The motion of waves is a very complex phenomenon and its study has applications in every aspect of our lives.

I will show how methods of mathematical analysis combined with asymptotic theory and numerical simulations can contribute to a better understanding of propagation and interaction of large amplitude ocean waves, both at the surface of the ocean and in its interior, in regular situations as well as in extreme events.

In particular, I will discuss the influence of bottom topography on wave dynamics. This is an important topic because of its relevance to coastal engineering, sediment transport, and global-scale propagation of tsunamis. The horizontal length scales of tsunamis are so large that even in the deep oceans, their impact depends on the particular topography of the coastline and inshore bathymetry. Uneven topography is also responsible for the generation of internal waves in the oceans. They are commonly observed in regions of sharp changes in temperature or salinity. Local measurements and photographs taken from orbital spacecraft show that their presence has a significant effect on the surface of the sea.