Modulational evolution of water-waves at the atmosphere-ocean interface: some similarities with non-linear optics

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The nonlinear Schrodinger equation, who is one of the most significant equations in physics, may model accurately the propagation of nonlinear waves. Some nonlinear waves are known to be unstable to side-band perturbation. This instability, known as the Benjamin-Feir [1] instability or Modulation Instability (MI) in a broader context, can be described by exact pulsating solutions, also referred to as Akhmediev Breathers (ABs). These solutions are of significant importance, since they describe the exact and complete growth and decay cycles of the modulation instability, leading to the Fermi Pasta Ulam [2] (FPU) recurrence.

We report here different theoretical, numerical and experimental evidence on AB dynamics, MI, and FPU recurrence, relative to water waves. We will show some similarities with the propagation of non-linear optic waves leading to breathers, dark and gray solitons and rogue waves.

The experiments were conducted in different wave tanks and air-sea interaction facilities. Our experimental results show a very good agreement with numerical results and emphasize a broad range of possible applications in nonlinear physics [3], [4], [5].





References

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