Nonequilibrium statistical behavior of a nonlinear dispersive wave system

Bruce Turkington
Department of Mathematics and Statistics
University of Massachusetts, Amherst
Lederle Graduate Research Tower, Box 34515
Amherst, MA 01003–9305, USA

Abstract

We consider a truncated nonlinear Schrödinger equation in one space dimension and study its relaxation toward statistical equilibrium using numerical simulations. This system is a reasonable toy model for geophysical problems in that its typical states consist of slowly-varying, large-scale coherent structures interacting with dispersive wave turbulence. Our interest is in studying the behavior of ensembles of solutions when a low mode of the system is disturbed out of equilibrium. To do this we invoke linear response theory to convert the near equilibrium relaxation problem to the computation of equilibrium correlations, computed by a Metropolis-type Monte Carlo method. The results are rather surprising. In some regimes, simple exponential relaxation is observed, while in other regimes metaequilibria form rapidly and then relax on extremely long time scales. From the standpoint of representing unresolved scales of motion, the main conclusion of our study is that an effective statistical closure is not necessarily an easy thing to achieve, even for a model system.