Chaotic dynamics of Heisenberg ferromagnetic spin chain with bilinear and biquadratic interactions

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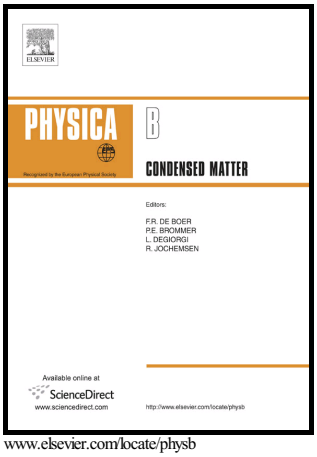

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Abstract

We investigate the chaotic dynamics of one dimensional Heisenberg ferromagnetic spin chain by constructing the Hamiltonian equations of motion. We present the trajectory and phase plots of the system with bilinear and also biquadratic interactions. The stability of the system is analysed in both cases by constructing the Jacobian matrix and by measuring the Lyapunov exponents. The results are illustrated graphically.

1. Introduction

The nature of evolution of different physical systems depends upon the nature of the forces acting on them and on their initial state [1]. Some of the systems are linear in nature and some are inherently nonlinear in nature. Nonlinear systems exhibit regular as well as irregular behaviours that depend on various factors [1]. Some of the interesting phenomena that follows such aspects of behaviour are solitons and chaos. Solitons are the solutions of a widespread class of weakly nonlinear dispersive partial differential equations which is of regular fashion and chaos is a state of disorder that can be observed in many natural systems. One of the system which exhibits this kind of nonlinear behaviour is the Heisenberg ferromagnetic spin system. Ferromagnetism is generated by the alignment of atomic magnets in domains. It exhibits spontaneous magnetisation even if there is no external magnetic field.

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