ABSTRACT

Solitons are localized travelling waves first discovered in shallow water. They are ubiquitous and exist in many kinds of systems from the sky to the laboratory, from physical to biological systems. In general, their importance as nonlinear waves and as nonlinear excitations in physical systems was well recognized in the past five decades. The advent of soliton as a stable solution of (1+1) dimensional integrable evolution equations in 1965 has made physicists working in different areas to look for solitons in their own fields of research. The concept of soliton is now widely used to explain various phenomena in condensed matter physics such as magnetic excitations, crystal dislocations etc. Among these, the investigation of the dynamics of magnetic materials is quite promising as the nonlinear effects are predominant in solids. With this in mind, we wish to investigate here the nature of nonlinear excitations in certain magnetic systems in detail.

This thesis contains the results of the investigations carried out on the nonlinear dynamics of the discrete and continuum ferromagnetic spin systems and their corresponding nonlinear evolution equations. We are primarily concerned with the nonlinear excitations in the (2+1) dimensional Heisenberg ferromagnetic spin
system in the semiclassical level. The spin systems studied here are characterized by models involving magnetic interactions such as bilinear, biquadratic and anisotropic interactions.

The thesis consists of ten chapters. In the first two chapters we present a brief introduction to nonlinear dynamics and also the dynamics of magnetic systems. Particularly, Chapter 1 being introductory contains the historical development of the concept of soliton and the details of various techniques used for finding soliton solutions to nonlinear evolution equations. Chapter 2 begins with the basic dynamics of magnetic systems with special consideration to Heisenberg ferromagnetic systems. Also, the second part consists of classical and semiclassical description of Heisenberg models with simple and fundamental interactions.

In Chapter 3, we propose a model Hamiltonian for a homogeneous 2-dimensional ferromagnetic spin system with bilinear interaction. The nonlinear dynamics of this model is obtained by deriving the equation of motion in the continuum limit by using suitable wave function. We employ Sine-Cosine function method to construct a set of new exact travelling wave solutions to the resulting nonlinear partial differential equation. Next in Chapter 4, we study the spin wave propagation and soliton stability in a 2-Dimensional ferromagnetic spin system with bilinear and anisotropic interactions. Also we analyze the effect of various interactions on the stability of soliton.

Chapter 5 explains the dynamics of 2-dimensional ferromagnetic spin sys-
tem taking into account biquadratic interactions. In **Chapter 6**, we present the nature of spin wave propagation in a square lattice model of FM spin system including biquadratic interactions. The dynamics is found to be governed by a perturbed nonlinear higher order partial differential equation in (2+1) -dimensions. Intrinsic localized spin modes associated with the dynamics are studied. Also we discuss the modulational instability conditions for the resulting perturbed equation.

**Chapter 7** deals with the nature of nonlinear spin excitations in a 2-dimensional discrete heisenberg ferromagnetic spin system with bilinear and anisotropic interaction. The dynamics is found to be governed by a (2+1) dimensional discrete nonlinear equation which possesses soliton solution. We analyze the linear stability of nonlinear plane waves in the presence of small perturbation. Next in **Chapter 8**, we study the localized excitations in higher dimensional discrete FM spin system including biquadratic interactions. Also we analyze the effect of instability in perturbed nonlinear equation analytically and graphically using linear stability analysis.

In **Chapter 9**, we propose a model Hamiltonian for inhomogeneous ferromagnetic spin system including bilinear, biquadratic and anisotropic exchange interactions. The nonlinear dynamics of this model is obtained by deriving the equation of motion in the continuum limit by using suitable wave function. Also we investigate the effect of nonlinear type of inhomogeneities such as cubic, bi-
quadratic, periodic and localized on the soliton propagation. We analyze the stability of soliton analytically and graphically using linear stability analysis.

Finally in Chapter 10, we investigate the dynamics of an inhomogeneous discrete FM spin system. The effect of periodic, localized and Gaussian inhomogeneities has been investigated using modulational instability analysis and the results have been discussed by dividing the region into three: long wavelength limit, short wavelength limit and Brillouin boundary zone.