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Loop-like periodic waves and solitons to the Kraenkel–Manna–Merle system in ferrites

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ABSTRACT

The Kraenkel–Manna–Merle system is investigated, which describes the propagations of the ferromagnetic particles in ferrite materials. A new series of the solutions are obtained via the auxiliary equation method. These solutions include periodic traveling wave solutions in Jacobi elliptic functions and soliton solutions in hyperbolic functions. Some of them are demonstrated in visualization. There exist loop-like periodic waves and loop-like solitons between independent variables related to the magnetization and the external magnetic fields vs. the time and space variables. The parameter influences on the periodic wave solutions are also discussed.

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1. Introduction

In last decades, along with a rapid advances in information technology for the requirement of massive data and high-density storages, a great lot of exciting progresses on ferromagnetic materials have been obvious to all. Some techniques have made it possible to fabricate ferromagnetic particles in nanoscale. It is significant to understand more about the properties of micro- and supermicro-structure in nanoscale ferromagnetic materials [1–13]. In consideration of such small nanoparticles, the magnetization can be regarded as homogeneous over these particles, and can be considered by a magnetic moment. The ferromagnetic particles can interact through a dipolar motions of the magnetic moments. The solitons arising from these interactions are steadily created. As a result, a wide range of soliton-type propagation phenomena have been investigated theoretically [13–15].

Kraenkel et al. investigated the propagation of short-wave in nanoscale saturated ferromagnetic materials from Maxwell equations with Landau–Lifshitz–Gilbert equation, and derived a new nonlinear evolution system [16]. Very recently, Nguepjouo et al. introduced a blend of coordinate transformations and expansion series of the magnetization density, and transformed the system in Ref. [16] into the following coupled equations [17]

$$\begin{cases} u_{xt} - uv_x + sv_x = 0, \\ v_{xt} + uu_x = 0, \end{cases} \tag{1}$$

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