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Nonautonomous matter wave bright solitons in a quasi-1D Bose-Einstein condensate system with contact repulsion and dipole-dipole attraction

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ABSTRACT

We investigate the existence and propagation properties of envelope solitons of an extended nonlinear Schr ödinger equation with the time-modulated dispersion, quadratic-cubic nonlinearities and linear gain or loss, which govern the nonlinear wave propagation in a nonautonomous quasi-1D Bose-Einstein condensate system with contact repulsion and dipole-dipole attraction. A novel class of nonautonomous bright soliton solutions on continuous-wave background is identified for the first time. It is shown that these localized structures possess interesting features that differ from the usual bright solitons. A rich variety of evolution behaviors, which include snakelike and periodic oscillating bright soliton dynamics, is revealed. The constraints of the system parameters to form these nonlinear localized structures are also suggested.

1. Introduction

The study of nonautonomous soliton propagation through nonlinear optical media has been one of the considerable recent interests [1–5]. This should not be surprising because the existence of these nonlinear waves have been demonstrated experimentally in a variety of settings, including nonlinear optics, fluid dynamics, condensed matter physics and plasma physics [5]. In general, the wave dynamics in some of the above mentioned areas and many other nonlinear mathematical-physics fields is governed by the well known nonlinear Schrödinger equation [6]. In the setting of Bose-Einstein condensates (BECs), such NLS equation is usually called the Gross-Pitaevskii (GP) equation [7].

To describe the wave propagation behaviors in realistic systems, one uses the variable-coefficient NLS equation and its variants. Noting that most of dynamical models are inhomogeneous in reality because of fluctuations in environmental environment and nonuniform medium, then the governing envelope wave equation should be included the spatially and/or

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