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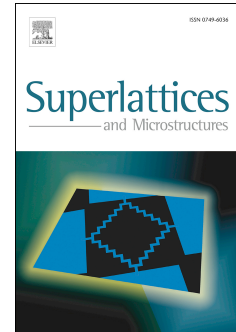
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# Optical solitons in parity-time-symmetric mixed linear and nonlinear lattice with non-Kerr law nonlinearity

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**Abstract:** This work presents an analytical study of the existence of solitons in non-Kerr law media modulated by the  $PT$ -symmetric mixed linear and nonlinear optical complex lattices. Four types of non-Kerr law nonlinearity are taken into account and these are parabolic law, power law, dual-power law as well as polynomial law. With the aid of inverse engineering method, various families of solitons are reported. The presented results are important for describing the propagation of optical solitons in parity-time-symmetric lattices.

**Keywords:** solitons; optical lattices;  $PT$ -symmetry; inverse engineering method.

## 1. Introduction

Optical lattice solitons are a product of precise balance of pulse diffraction, lattice modulations and nonlinear effects. Since the nonlinear periodic lattices was first fabricated for the first time by the group of professor Fleischer using the light-induced technology in 2003 [1], lattice solitons have been studied as a hot topic in nonlinear optics. Optical lattices, making the refractive index modulating profile, can be realized in the cross section of nonlinear medium, one may obtain some new types of solitons and manipulation of solitons by tuning the physical parameters of optical lattices or changing the structures of optical lattices [2].

With the introduction of the concept of parity-time ( $PT$ ) symmetric complex-valued potential in quantum mechanics by Bender and Boettcher in 1998 [3], recently the research focus of optical lattice solitons transferred from real domain to complex domain. The  $PT$ -symmetric complex potential can be achieved in optical lattices by introducing a complex refractive index profile  $n(x) = n_r(x) + in_i(x)$ , in which the real part should be an even function (i.e.

$n_r(x) = n_r(-x)$ ) and the imaginary part should be a odd function (i.e.  $n_i(x) = -n_i(-x)$ ) [3-5].

It must be noted that previous studies mainly focused on the soliton properties in  $PT$ -symmetric linear or nonlinear optical lattices, the defect solitons, gap solitons, multi-hump solitons and some other types of solitons were reported [6-21]. However, the investigate of existence, stability, and dynamics of solitons in media with imprinted  $PT$ -symmetric mixed linear and nonlinear optical lattices just starts [22-25]. The purpose of the present work is to study the existence of solitons in various non-Kerr law media modulated by  $PT$ -symmetric mixed linear and nonlinear optical complex lattices. There are four types of nonlinearity, namely the parabolic law, power law,

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