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Phase engineering of chirped rogue waves in Bose-Einstein condensates with a variable scattering length in an expulsive potential. (English) Zbl 1477.35243

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Summary: We consider a cubic Gross-Pitaevskii (GP) equation governing the dynamics of Bose-Einstein condensates (BECs) with time-dependent coefficients in front of the cubic term and inverted parabolic potential. Under a special condition imposed on the coefficients, a combination of phase-imprint and modified lens-type transformations converts the GP equation into the integrable Kundu-Eckhaus (KE) one with constant coefficients, which contains the quintic nonlinearity and the Raman-like term producing the self-frequency shift. The condition for the baseband modulational instability of CW states is derived, providing the possibility of generation of chirped rogue waves (RWs) in the underlying matter-wave (BEC) model. Using known RW solutions of the KE equation, we present explicit first- and second-order chirped RW states. The chirp of the first- and second-order RWs is independent of the phase imprint. Detailed solutions are presented for the following configurations: (i) the nonlinearity exponentially varying in time; (ii) time-periodic modulation of the nonlinearity; (iii) a stepwise time modulation of the strength of the expulsive potential. Singularities of the local chirp coincide with valleys of the corresponding RWs. The results demonstrate that the temporal modulation of the s-wave scattering length and strength of the inverted parabolic potential can be used to manipulate the evolution of rogue matter waves in BEC.

MSC:

35Q55	NLS equations (nonlinear Schrödinger equations)
35Q60	PDEs in connection with optics and electromagnetic theory
35C08	Soliton solutions
78A60	Lasers, masers, optical bistability, nonlinear optics
78A45	Diffraction, scattering
78A40	Waves and radiation in optics and electromagnetic theory
82C10	Quantum dynamics and nonequilibrium statistical mechanics (general)
37K10	Completely integrable infinite-dimensional Hamiltonian and Lagrangian systems, integration methods, integrability tests, integrable hierarchies (KdV, KP, Toda, etc.)

Keywords:

chirp rogue wave; Bose-Einstein condensate; Kundu-Eckhaus equation; Gross-Pitaevskii equation; nonlinear Schrödinger equation

Full Text: DOI arXiv

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