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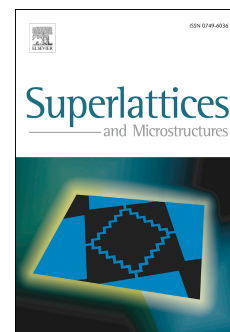
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# Dark and bright soliton solutions for a three-dimensional Gross-Pitaevskii equation with distributed time-dependent coefficients in the Bose-Einstein condensation

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## Abstract

Under investigation in this paper is a three-dimensional Gross-Pitaevskii equation with the distributed time-dependent coefficients, which describes the phenomena associated with the three-dimensional Bose-Einstein condensation. Under the constraint  $\alpha(t) = 2\beta(t)$ , we obtain the bilinear forms, dark and bright  $N$ -soliton solutions via the Hirota method and symbolic computation, where  $t$  is the time,  $\alpha(t)$  and  $\beta(t)$  are the coefficients for the strength of the quadratic potential and diffraction, respectively. Specially, compared with the bright soliton solutions previously reported, we decrease one constraint and obtain more soliton parameters. We give the existence constraints of the dark  $N$  solitons and bright  $N$  solitons, respectively. Choosing the diffraction and gain/loss coefficients, we observe the growth, decay, periodic oscillation, periodic collapse and revival of the dark and bright solitons. Relationships between the BEC time-dependent coefficients and soliton properties are studied. With the help of the asymptotic and graphic analysis, elastic interactions of the dark and bright two solitons are exhibited.

**Keywords:** Three-dimensional Gross-Pitaevskii equation; Bose-Einstein condensation; Soliton solutions; Symbolic computation; Hirota method

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