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Article

Source type

Journal

ISSN

24700045

DOI

10.1103/PhysRevE.107.044218

Publisher

American Physical Society

Original language

English

PubMed ID37198780 [↗](#)[View less](#) [^](#)

Compacton existence and spin-orbit density dependence in Bose-Einstein condensates

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Abstract

We demonstrate the existence of compactons matter waves in binary mixtures of Bose-Einstein condensates (BEC) trapped in deep optical lattices (OL) subjected to equal contributions of intraspecies Rashba and Dresselhaus spin-orbit coupling (SOC) under periodic time modulations of the intraspecies scattering length. We show that these modulations lead to a rescaling of the SOC parameters that involves the density imbalance of the two components. This gives rise to density dependent SOC parameters that strongly influence the existence and the stability of compacton matter waves. The stability of SOC-compactons is investigated both by linear stability analysis and by time integrations of the coupled Gross-Pitaevskii equations. We find that SOC restricts the parameter ranges for stable stationary SOC-compacton existence but, on the other side, it gives a more stringent signature of their occurrence. In particular, SOC-compactons should appear when the intraspecies

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interactions and the number of atoms in the two components are perfectly balanced (or close to being balanced for the metastable case). The possibility to use SOC-compactons as a tool for indirect measurements of the number of atoms and/or the intraspecies interactions is also suggested. © 2023 American Physical Society.

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the inter-SOC case (Equation presented) is a diagonal while (Equation presented) is off-diagonal
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