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Peer Review

Review of: "Multidimensional Soliton Systems: an Update"

Cristian Mejía-Cortés[1]

1. Physics, Universidad del Atlántico, Colombia

This article serves as a critical and timely summary of the rapidly evolving landscape of multidimensional soliton research, ranging from nonlinear optics to atomic physics. By providing a condensed update to recent comprehensive reviews, the author successfully highlights the transition from theoretical predictions to significant experimental realizations, such as the observation of multiple quantum droplets in prolate Bose-Einstein condensates. This cross-disciplinary approach is vital, as it identifies how beyond-mean-field effects and quantum fluctuations are now being utilized to stabilize states against collapse, a fundamental challenge in the study of self-trapping matter waves.

Furthermore, the work underscores the innovative theoretical frontiers being explored, such as the introduction of fractional diffraction into optical systems and the use of physics-informed neural networks for modeling nonlinear dynamics. The manuscript emphasizes the importance of these new mathematical frameworks in predicting stable 2D and 3D vortex solitons in media where they were previously considered unstable. This theoretical framework is essential for the development of next-generation photonic devices and the manipulation of complex topological structures like optical skyrmions.

Finally, the article highlights the breakthrough in understanding the stability of anisotropic vortex configurations in dipolar BECs. By detailing how vorticity oriented perpendicular to dipoles′ polarization can lead to stable 3D states, the author provides a roadmap for future experiments in quantum matter. The inclusion of diverse trapping potentials, such as the Möbius strip and toroidal potentials, demonstrates the review article′s value in pushing the boundaries of nonlinear science into nontrivial topologies, ensuring its relevance to researchers in hydrodynamics, plasma physics, and condensed matter.

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Declarations

Potential competing interests: No potential competing interests to declare.