
Energy Extraction from Q-balls and Other Fundamental Solitons

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Abstract

Energy exchange mechanisms have important applications in particle physics, gravity, fluid mechanics, and practically every field in physics. In this Letter we show, both in the frequency and time domain, that energy enhancement is possible for waves scattering off fundamental solitons (time-periodic localized structures of bosonic fields), without the need for rotation nor translational motion. We use two-dimensional Q-balls as a test bed, providing the correct criteria for energy amplification, as well as the respective amplification factors, and we discuss possible instability mechanisms. Our results lend support to the qualitative picture drawn in Saffin *et al.* (preceding Letter, Q-ball superradiance, Phys. Rev. Lett. 131, 111601 (2023).); however, we show that this enhancement mechanism is not of superradiant type, but instead is a "blueshiftlike" energy exchange between scattering states induced by the background Q-ball, which should occur generically for any time-periodic fundamental soliton. This mechanism does not seem to lead to instabilities.

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