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Binary matter-wave compactons induced by inter-species scattering length modulations (Article)

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Abstract

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Binary mixtures of quasi one-dimensional Bose-Einstein condensates (BECs) trapped in deep optical lattices (OLs) in the presence of periodic time modulations of the inter-species scattering length are investigated. We adopt a mean field description and use the tight-binding approximation and averaging method to derive averaged model equations in the form of two coupled discrete nonlinear Schrödinger equations (DNLSEs) with tunneling constants that nonlinearly depend on inter-species coupling. We show that for strong and rapid modulations of the inter-species scattering length, the averaged system admits exact compacton solutions, e.g. solutions that have no tails and are fully localized on a compact which is achieved when the densities at the compact edges are in correspondence with zeros of the Bessel function (zero tunneling condition). Deviations from exact conditions give rise to the formation of quasi-compactons, e.g. non-exact excitations which look like compactons for any practical purpose, for which the zero tunneling condition is achieved dynamically thanks to an effective nonlinear dispersive coupling induced by scattering length modulation. The stability properties of compactons and quasi-compactons are investigated by linear analysis and numerical integrations of the averaged system, respectively, and the results are compared with those of the original time dependent driven system. In particular, the occurrence of delocalizing transitions with the existence of thresholds in the mean inter-species scattering length is explicitly demonstrated. Under proper management conditions, stationary compactons and quasi-compactons are quite stable and robust excitations that can survive on a very long time scale. A parameter design and a possible experimental setting for the observation of these excitations are briefly discussed. © 2017 IOP Publishing Ltd.

Author keywords

binary BEC compactons discrete nonlinear Schrödinger equation optical lattice

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