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Ultrasolitons: multistability and subcritical power threshold from higher-order Kerr terms

David Novoa, Daniele Tommasini, Humberto Michinel

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We show that an optical system involving competing higher-order Kerr nonlinearities can support the existence of ultrasolitons, namely extremely localized modes that only appear above a certain threshold for the central intensity. Such new solitary waves can be produced for powers below the usual collapse threshold, but they can also coexist with ordinary, lower-intensity solitons. We derive analytical conditions for the occurrence of multistability and analyze the dynamics of the different kinds of fundamental eigenmodes that can be excited in these nonlinear systems. We also discuss the possible transitions between solitary waves belonging to different nonlinear regimes through the mechanism of soliton switching.

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