Optical dispersive shock waves in parametric wave mixing

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Abstract:

Recently dispersive shock waves (DSW) have been predicted and observed both in superfluids (Bose-Einstein condensates [1]) and in nonlinear optics [2] for a variety of bright and dark localized wave-packets, i.e. common spatial beams or pulses propagating under the action of weak diffraction or dispersion, respectively. We extend the analysis of DSW to the realm of parametric wave mixing, discussing mainly two settings which involve (i) four-wave mixing occurring via Kerr nonlinearity in optical fibers and (ii) second-harmonic generation in quadratic media, respectively. In the former case we show how DSW develop from an input modulated wave whose evolution is described in the framework of the scalar NLS equation with frequency comb structure. According to the NLS model we predict and observe the occurrence of arrays of twin wave-breaking points which give rises to colliding DSW under a variety of launching conditions. In the second case we highlights experimentally feasible situations where frequency doubling undergoes wave-breaking, discussing in particular how the regularization in terms of DSW can coexist and compete with a different wave-breaking mechanisms based on modulational instability. Such competition between different breaking mechanisms involving either a gradient catastrophe or modulational instability is not present in the scalar NLS equation but seems to be a sufficiently general scenario which can be found also in other models.

References:

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