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Rogue-wave formation scenarios for the focusing nonlinear Schrödinger equation with compactly-supported, parabolic initial data

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Abstract. We study the (1+1) focusing nonlinear Schrödinger equation for an initial condition with compactly supported parabolic profile and phase depending quadratically on the spatial coordinate. In the absence of dispersion, using the natural class of self-similar solutions, we provide a criterion for blowup in finite time, generalising a result by Talanov et al. In the presence of dispersion, we numerically show that the same criterion determines, even beyond the semiclassical regime, whether the solution relaxes or develops a high-order rogue wave, whose onset time is predicted by the corresponding dispersionless catastrophe time. The sign of the chirp appears to determine the prevailing scenario among two competing mechanisms for rogue wave formation. For negative values, numerical simulations are suggestive of the dispersive regularisation of a gradient catastrophe described by Bertola and Tovbis for a different class of smooth, bell-shaped initial data. As the chirp becomes positive, the rogue wave seems to result from the interaction of counterpropagating dispersive dam break flows, as in the box problem recently studied by El, Khamis, and Tovbis. If time allows, preliminary results about extending the analysis to the Manakov system, with a much richer phenomenology, will be shown.

This work has been carried out in collaboration with F. Demontis, G. Ortenzi, and G. Roberti.

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