Super-focusing and mirroring of Airy pulses propagating in fibers with third order dispersion.

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Abstract:
Truncated Airy pulses [1-3] were launched in an optical fiber close to its zero dispersion point allowing the effect of third order dispersion (TOD) to play a dominant role in the dynamics of pulses. When the truncated Airy pulse propagates in the presence of pure quadratic dispersion it lives for a finite distance until it reaches its divergence area. However when the pulse dynamics is governed by a pure TOD with positive sign, we found a somehow surprising result. The pulse reaches the focal point fast, then undergoes a mirror transformation and continues to propagate accelerated in the opposite direction. At the focal point all the pulse energy is concentrated in a very short temporal slot, featuring a very interesting pulse compression technique. Such a transformation was not observed when the sign of the TOD was negative [4]. When both dispersion terms act on the pulse, the focal point extends to a finite area of truncated Airy pulse "non-existence". The size of the area depends on the relative strength of the third order dispersion term with respect to its second order counterpart. After this area, the pulse reemerges again being mirror-transformed and continues its evolution. Such a propagation behavior is also realizable under the action of negative TOD by reversing the initial acceleration direction of the Airy pulses. For each value of pulse width there is a minimal value corresponding to the ratio between the third and second order dispersion strengths starting from which we can observe the mirror effect. Below this value the pulse vanishes. In a strongly nonlinear regime we expect to observe soliton shedding out of the Airy pulse structure [5], where the frequency of the ejected soliton is controlled by the TOD strength.

References:
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