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► **To cite this version:**

Kamal Hammani, Christophe Finot. A comment on "Research on the nonlinear pulse propagation by numerical analysis" by Li Li and Aihan Yin, *Optik*, vol. 12 (13) (2011) pp. 1195-1200. *Optik*, 2012, 123 (19), pp.1805-1806. 10.1016/j.ijleo.2011.11.091 . hal-00699102

HAL Id: hal-00699102

<https://hal.science/hal-00699102>

Submitted on 19 May 2012

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A comment on “Research on the nonlinear pulse propagation by numerical analysis” by Li Li and Aihan Yin, *Optik*, vol. 12 (13) (2011) pp. 1195-1200

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In the article entitled “Research on the nonlinear pulse propagation by numerical analysis” [1], Li Li and Aihan Yin summarize the key elements affecting the nonlinear propagation of an optical pulse in an optical fiber. Based on the NonLinear Schrödinger Equation (NLSE) and on well-known scaling laws [2], a discussion is carried out on the influence of the dispersive regime of propagation and on the initial chirp.

In this article, a point has attracted our attention. Indeed, in Figs 3(a) and 4(a), some strong oscillations develop and the authors seem to interpret those oscillations as a splitting of the initial Gaussian pulse into numerous subpulses having a lower peak power. It is now well-understood that the interplay between normal dispersion and Kerr nonlinearity may lead to the emergence of strong oscillating substructures in the wings of any pulse [3, 4]: this effect, commonly known as wave-breaking, appears when the heavily chirped central part of the pulse overlaps the wings of the pulse [5] and the only pulse shape that is not affected by such an effect is the parabolic intensity profile [6, 7]. Nevertheless, the development of the temporal oscillations in the wings of the pulse does not lead to a pulse splitting as can be observed for solitonic regime [8] and several different analytical approaches based on the analysis of single pulse have been found to accurately reproduce the dynamics recorded in the normal regime of dispersion [9, 10].

Therefore, regarding the present article, we do not believe that wave-breaking may explain the observed dynamics and the subpulses observed in the normal regime of dispersion. It seems for us more realistic that the so-called pulses highlighted by the numerical simulations of Li *et al.* are the result of a numerical artifact. More precisely, we would like to emphasize that such oscillations should not be present during the propagation of a single isolated Gaussian pulse and therefore are directly linked to the use of periodic boundary conditions in the fast Fourier transform algorithm that is intensively used in the usual split-step Fourier method [2]. In other words, due to these periodic boundary conditions, the authors have implicitly investigated the evolution of a periodic train of Gaussian pulses separated by the duration of the temporal window that is used numerically. Consequently, the observed oscillations should be interpreted as the temporal overlap of adjacent pulses that continuously broaden in the normal dispersion regime. The pulses being highly chirped, two local instantaneous frequencies will linearly overlap, which will induce a sinusoidal beating. Such a behavior can in some extent be related to the well-known Talbot effect [11]. To illustrate this artifact, we have reproduced in Fig. 1 the numerical simulations of the authors by taking the same initial pulse and the same temporal window. Results clearly outline the large temporal broadening of the pulse that exceeds the width of the temporal window. Therefore, the previously mentioned oscillations appear in the edges of the pulse first and their temporal extent then increases as the broadening (i.e. the overlap by a virtual adjacent pulse) increases.

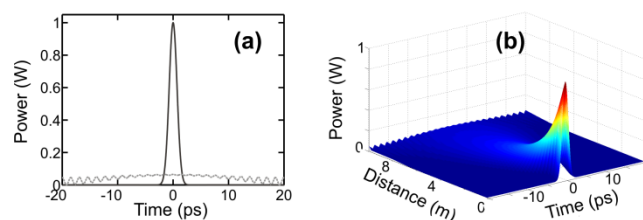


Figure 1. Simulation of the propagation of a Gaussian pulse in a fiber with the same parameters as in Ref [1] (a). The output temporal intensity profile (grey) is compared to the input profile (black). (b) Longitudinal evolution of the temporal intensity profile.

If we now take into account a temporal window that is twice the size of the previous one, those oscillations disappears (Fig. 2a and 2b): the pulse under consideration has not experienced a sufficient broadening so that it is still fully contained in the temporal window with no interaction with a virtual adjacent pulse. Finally, using two adjacent pulses spaced by the initial temporal window (Fig. 2c), we clearly reproduce all the aforementioned features.

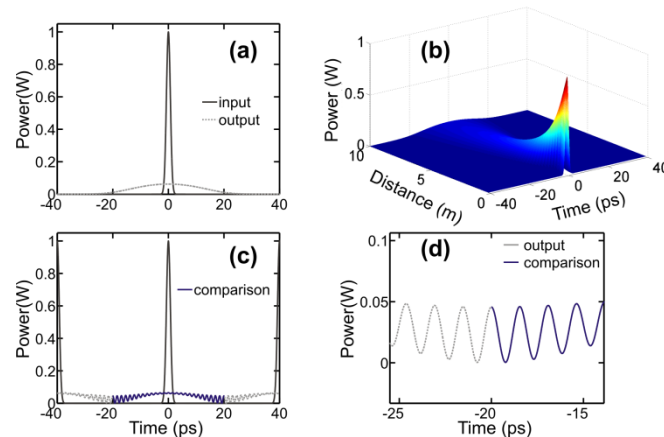


Figure 2. (a) Same as Fig 1a with a larger temporal window. (b) Longitudinal evolution. (c) Comparison between output signal in Fig. 1a and the output signal with two adjacent pulses. (d) Magnification of Fig. 2(c).

Let us also stress that if further propagation of high power pulses occurs, the sinusoidal beating will further evolve into a train of dark solitons, which has been experimentally demonstrated as soon as 1990 [12]. Such nonlinear evolution in the overlapping regions has also been found to be a crucial limitation of optical pulse processing devices such as Mamyshev regenerators[13, 14] or can also affect evolution in normally dispersive amplifiers [15]. Finally, let us add that similar situations may also occur in the spatial domain [16].

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