Manipulation of solitons in optical fiber experiments

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In nonlinear physics, more precisely in integrable system like Sine-Gordon (SG), Korteweg–de Vries (KDV) and the one dimensional nonlinear Schrödinger equation (1D-NLSE), the concept of fundamental soliton plays a key role in understanding the dynamics due to its main property : the preservation of its shape during the evolution and of its parameters when interacting with other solitons. In 1D-NLSE, a spatially localized wavefield contain a high-order soliton solution known as a bound state of solitons, they form when two or more fundamental solitons coexist spatially with no relative velocity [1]. In this work, we use optical fibers to study the spatio-temporal dynamics associated with a localised phase modulation of a bound state of solitons in order to manipulate the velocity of a selected soliton. Finally we compare the results with a perturbed Inverse Scattering Transform spectrum theory (IST) in which the signal is decomposed into solitons characterized by their amplitudes and velocities.

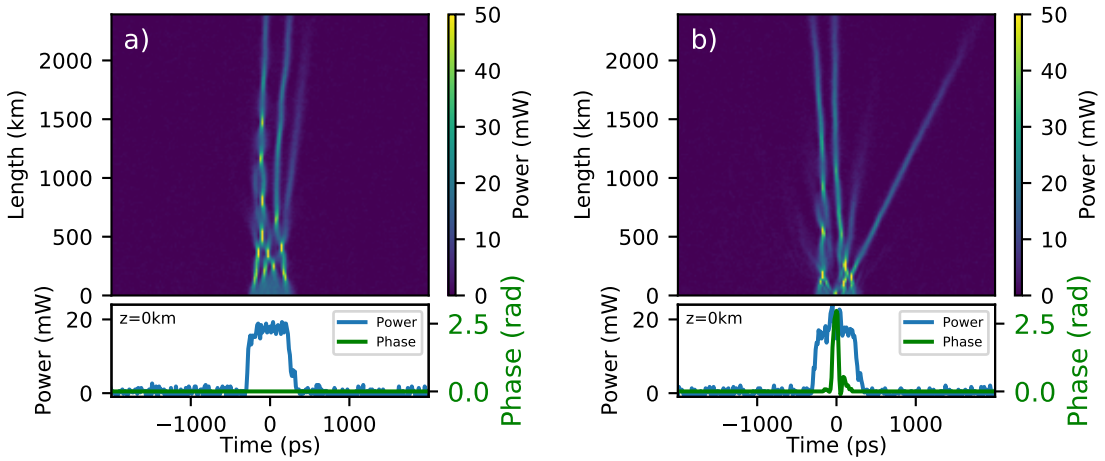

Figure 1. Comparison of experimental spatio-temporal evolution of an unperturbed square-shaped light pulse (a) and localised phase modulated square-shaped light pulse (b) with the respective initial conditions.

Experimentally, we generate a square-shaped light pulse composed of several solitons that is launched into a Recirculating Optical Fiber Loop. Each loop, a portion of the light is collected allowing us to record the spatio-temporal dynamic in single shot [2]. Figure 1 shows the propagation of a square-shaped light pulses composed initially of 5 solitons over 2400 km. In the first panel (a) no phase modulation is applied exhibiting the spatio-temporal dynamic of a bound state of solitons. In the second panel (b) a phase modulation is applied initially, changing the velocity of one of the soliton. [2].

References

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