Elliptically polarized few-optical-cycle solitons: structures and its dynamics

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Abstract:

The progress in the last decade in laser science has established a new field of extreme nonlinear optics, which involves very short laser pulses comprising only a few optical cycles (see, e.g., [1]). This actually raises the question of whether the concept of optical solitons can be extended to this new regime. Indeed, some important results have recently been obtained by employing a unidirectional approach, which is based on the slowly evolving wave field approximation (SEWA). Within this approach a few-optical-cycle solitons with linear [2] and circular [3] polarization are found and it is shown that they play an important role in the pulse propagation dynamics. Moreover, a circularly polarized soliton solution within the framework of an exact full wave equation is also found indicating that the soliton concept can be extended to higher intensities and shorter durations where the SEWA is not applicable [4]. In this report, we generalize the few-cycle soliton concept to arbitrary polarization states, in particular we show that these wave solitons cover the range from the fundamental Schrodinger solitons, which occur for long pulses involving many field oscillations, to extremely short pulses, which contain only one optical period. We prove numerically that they are stable and play a fundamental role in the pulse propagation dynamics. We also show that the concept of the high-order solitons can be effectively applied to the few-cycle regime and used for efficient pulse compression down to the single cycle duration. Dynamical properties of elliptically polarized few-cycle solitons will also be discussed, where particular attention to the properties of pair collisions of circularly polarized solitons rotating in opposite directions will be given.

References:

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