

Dissipative solitons in passive mode-locked fiber lasers with nonlinear polarization rotation technique

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Abstract:

The passive mode-locked fiber lasers are of great interest for a study of diversified features of a soliton dynamics. Dispersion parameters and a form of intensity-dependent nonlinear losses in the fiber lasers with nonlinear polarization rotation technique can be changed in a very large range that provides a distinct manifestation of varied soliton properties including a quantization of an intracavity radiation into individual identical solitons, multi-stability and multi-hysteresis related with set of pulses in a laser cavity, multi-stable steady-states of single soliton due to its different pedestal, a coexistence of steady-state solitons and cw-component of radiation, a quantization of binding-energy for a pair of interacting structural solitons (the binding-energy can be large and comparable with an energy of an individual soliton) and so on [1–3]. Due to strong interaction and great binding energy, intracavity solitons can form structures analogous to different states of the matter [1]. In particular, in real experiment we have identified a gas, a supersonic gas flow, a liquid, a polycrystal and a crystal of solitons. In certain cases a train of equidistant pulses fills completely a laser resonator and harmonic passive mode-locking is realized. In numerical experiment we have demonstrated the realization of highly-stable information soliton sequences with any required distribution along the soliton train of various types of bonds between neighboring pulses [3].

Existing theories describing above mentioned peculiarities of a soliton dynamics are based on model with isotropic laser fiber. In this paper we develop a theory which takes into account the birefringence of the fiber. In the frame of this model, for some laser parameters, a critical dependence of nonlinear losses on intensity of radiation can be realized that results in a change of the nature of soliton interaction and of properties of lasing regimes. Soliton interaction and lasing regimes realizing under such conditions are analyzed.

References:

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