# Classical and quantum description of dissipative spatial solitons

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Considerable interest in the dissipative optical solitons could be explained by the potential for using these structures in information applications of quantum optics [1]. Moreover, interest to the fundamental properties of these structures has increased due to the recent successful obseravations of the resonator solitons in semiconductors devises [2]. In contrast to conservative solitons, dissipative ones are characterized by high stability, which is due to realizing a dynamic balance of energy afflux and drain. At the same time, the possibilities of using dissipative solitons are directly related to their quantum features, which have not been studied in such detail. This work is devoted to a study in the framework of the semiclassical theory of a wide-aperture laser with saturable absorption and external support radiation, proposed in [3].

We consider the resonant interaction of a classical field with two different media consisting of two-level atoms placed in a cavity. The first media carries out the laser generation, while the second one is providing the saturable absorption of the generation radiation (fig. 1). The author of [4] showed that such an interaction, with the proper selection of parameters, forms stable spatial field structures in the cavity. Besides, in the study [5] it is shown that the presence of an absorbing medium under saturation conditions does not change noise level of the quantum state of the field what allows to further use the considered scheme to create spatially localized field states with suppressed quantum noise.

We analyze in depth the system using the consistent construction of the quantum Liouville equations for atomic media and the wave equation for the classical field. Adiabatic elimination allows us to construct a closed equation for the laser generation field. The possibility of using the adiabatic approximation arises from the assumption that the laser generation evolves in time much more slowly than atomic media.

The obtained solution makes it possible to study the spatial structure of a laser soliton. Also, a numerical calculus of the solitons stability is performed. We will use this result in the development of the quantum theory of spatial dissipative solitons, as well as for studying the quantum properties of solitons as quasi-particles.

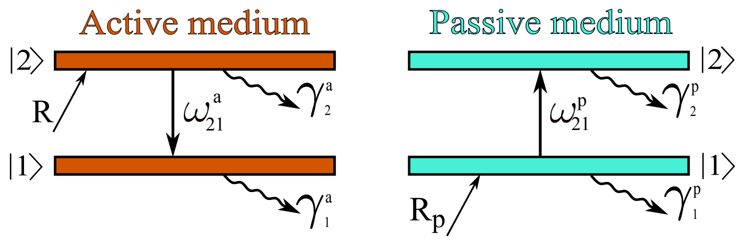


Figure 1: The schematic draw of the active and passive media.

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