Domain walls and dissipative solitons in polariton systems

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Abstract:

The formation and the dynamics of dissipative domain walls and solitons in semiconductor microcavities with coherent optical pump are considered for the case when strong coupling between the excitons and the photons generates hybrid light-matter excitations called polaritons. To describe the dynamics of the photons and the excitons in mean field approximation we use the standard mathematical model consisting of two coupled equations for the photon E and the exciton ψ fields

$$\partial_t E - i(\partial_x^2 + \partial_y^2)E + (\gamma_1 - i\Delta_1)E = i\psi + E_p \quad (1)$$

$$\partial_t \psi - i\sigma(\partial_x^2 + \partial_y^2)\psi + (\gamma_2 - i\Delta_2 + i|\psi|^2)\psi = iE, \quad (2)$$

where γ_1 and γ_2 are the losses for the photon and the exciton subsystems, Δ_1 and Δ_2 are the detunings of the photon and exciton resonances from the pump frequency, E_p is the pump filed, σ is the diffraction coefficient for the exciton field.

The waves in the linearized system (1)-(2) can be described by the dispersion characteristics having two branches. In recent years a number of papers were published reporting dissipative structures nestling on the lower polariton mode [1]-[3]. In this talk we address a new kind of optical domain walls having two very different characteristic scales. The motion of the kinks, their pinning on inhomogeneities and their mutual interaction are discussed. The formation and the stability of the bound states of the domain walls (dissipative solitons) are also considered.

Special attention is paid to two-dimensional case. It is shown that for some parameters the axially symmetric dissipative solitons are linearly stable. It is also demonstrated by direct numerical simulation that the development of the radial and azimuthal instabilities can result in the formation of very interesting objects like dissipative breathers.

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References:

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