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COMPUTATION AND ANALYSIS OF LONGITUDINAL OPTICAL MODES IN MULTISECTION RING AND EDGE-EMITTING SEMICONDUCTOR LASERS

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We present a method which allows computing and analyzing longitudinal optical modes in multisection ring and edge-emitting lasers which can be schematically represented by a set of n_s *sections* all interconnected by their edges. We assume, that within each section the spatial-temporal dynamics of the complex slowly varying amplitudes of counter-propagating optical fields $E = \binom{E^+}{E^-}$ are governed by the traveling wave equations [1]

$$-i\partial_t E(z,t) = \mathcal{H}(\beta^{\pm}) E, \quad \mathcal{H}(\beta^{\pm}) = \begin{pmatrix} i\partial_z - \beta^+ & -\kappa^- \\ -\kappa^+ & -i\partial_z - \beta^- \end{pmatrix}, \quad z \in [z_k', z_k''], \quad k = 1, \ldots, n_s, \quad (1)$$

where the complex propagation factors $\beta^{\pm}(z,t)$ depend on the slow dynamics of the carriers. The boundary conditions determining the optical fields *incoming* into all laser sections are defined by linear combination of all fields *leaving* all sections.

The concept of optical modes plays a significant role for understanding laser dynamics in general [2]. They represent the natural oscillations of the electromagnetic field and determine the optical frequency and the life time of the photons contained in the given laser cavity. These modes are pairs $(\Omega(\beta^{\pm}), \Theta(z, \beta^{\pm}))$ of eigenvalues and eigenvectors of the spectral problem

$$\Omega\Theta(z,t) = \mathcal{H}\left(\beta^{\pm}\right) \Theta(z,t), \quad z \in [z_k', z_k''], \quad k = 1, \ldots, n_s, \quad (2)$$

which satisfies the boundary conditions and is determined at *instantaneous* distributions of $\beta^{\pm}(z,t)$.

In this work we discuss the algorithm for computation of the instantaneous modes of nearly arbitrary multisection semiconductor laser. We apply the optical mode computations for explanation of different dynamical regimes in ring and other multisection edge-emitting lasers. The computation of the optical modes leads to a better understanding of the nonlinear dynamics of semiconductor laser devices and is very useful when optimizing existing semiconductor lasers or designing new devices with a particular dynamical behavior.

REFERENCES

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