Dynamics of transverse field structure in lasers and nonlinear media

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INTRODUCTION

When the light beam is propagated through nonlinear media the space inhomogeneity of gain and refraction index arises due to saturation. This effects is manifested as selfaction of beam. New modification of method was elaborated for the solution of beam selfaction problem and has been successfully applied to the study of the transverse dynamics of the beam in nonlinear resonant media (Ref.1,2).

BEAM PROPAGATION IN ACTIVE MEDIA

Let us consider of well-known wave equation describing the light propagation through two-level media with gain or absorption with homogeneously broadened line:

$$2i\partial E/\partial z+(1/r)\partial E/\partial r+\partial^2 E/\partial r^2=-\kappa LE(\delta+i)/(1+\delta^2+S|E|^2), \qquad (1)$$

where κ is the linear absorption coefficient; L is the medium length; δ is the detuning scaled to the inverse of the homogeneous lifetime; S is the saturation parameter. By application of the method from Ref.1,2 we can take into account only three modes and we can suppose that (Ln is Laguerre polynomial)

$$E=\sum An(z)Ln(\eta r^2)exp(-Pr^2/2),\ P=\eta+i\xi,\ P=P(z),$$

The results of simulations show the ring structure formation on the beam wings.[3]

THE DYNAMICS OF TRANSVERSE STRUCTURE OF LASER BEAM

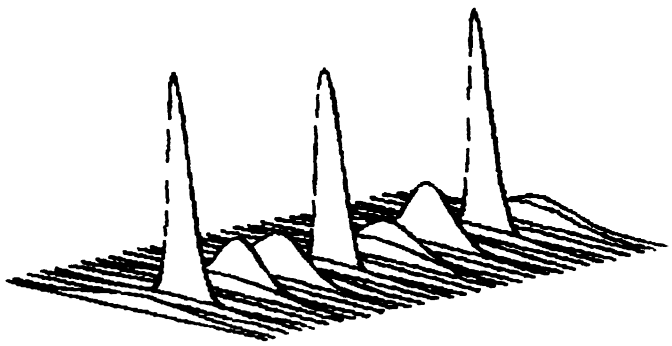
Let we consider the ring unidirectional cavity,without any of astigmatism and with a spherical mirror with radius R and Gaussian reflection profile $Re(r)=Re\,exp(-2r\times r/\omega d)$. Fast relaxed active media fills the whole cavity. We have to use the boundary condition on spherical mirror:

$$\sqrt{T_+}\,exp(-P_+r^2/2) = R_e\sqrt{T_-}\,exp(-(P_-+2/\omega_d^2+i/R)r^2/2), \qquad (2)$$

where symbol "+"-reference to the parameters after mirror, "-"- before one. The solution of equations for An and (2) is the nonlinear transformation of field from one round trip to another. In the fig. the sequence of 50 round-trips transverse beam profiles is performed for $\kappa L=-2, \delta=0, Re=0.5, \omega d=6, R=1$.

CONCLUSION

The use of method allows to do numerical simulation one or two order faster than in ordinary numerical schemes. Thus we can formulate and solve the complicated problems of nonlinear dynamics of beams. These problems are mode deformation, mode-locking, mode competition and cooperative effects, the investigation of transverse pattern structure, and quaziperiodic and chaotic regimes in laser.



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