Chapter 8

Conclusions

In Chapter 2, author has studied the basic nonlinear phenomena of relativistic and ponderomotive self-focusing in a non-uniform plasma channel using elliptic Gaussian trial function. Equations for the normalized beam width parameter and longitudinal phase are derived using variational approach. In the absence of plasma channel, diffraction is the dominant mechanism leading to monotonically increase in $X_n$ and $Y_n$. Occurrence of individual self-focusing of $X_n$ and $Y_n$ as well as phenomenon of cross-focusing is observed when the finite channel term is introduced. Longitudinal phase is observed to be positive or negative with distance of propagation in this analysis. Further, stability properties of beam dynamics are studied, and it is found that beam is marginally stable in the absence of any dissipation mechanism. In Chapter 3, author has introduced two scale lengths for varying diffraction and nonlinearity. With the advancement of laser science and pulse shaping technology alongwith the novel idea of light controlling light, it may be possible to tailor underdense plasma in which diffraction, dispersion and nonlinearity can be controlled. Author has studied the self-focusing and self-phase modulation of laser beam with relativistic, ponderomotive nonlinearity alongwith non-uniform plasma channel. Again equations for beam width and phase are derived using trial function as Gaussian beam. Beam width equation is further manipulated by putting it in the form of a quasiparticle moving in an effective potential. All the cases with relativistic and ponderomotive self-focusing alongwith non-uniform plasma channel are studied. It is found that by combining
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the effects of RSF and PSF, catastrophic self-focusing is observed. Long propagation distance is possible only when the combined effects of RSF, PSF and CF are taken into account. Beam is marginally stable in the absence of any dissipation mechanism in this investigation also.

Chapter 4 presents some interesting aspects associated with the propagation of the various order HGBs and the results are appreciated through the critical curves and the dependence of the beam width parameter on various factors. It is seen that the critical curves and self-focusing show strong dependence on the order of the HGB. Equation for normalized beam width and phase is derived using variational approach. When free space propagation term is not considered, the beam defocuses for all values of $n$. However, when relativistic as well as ponderomotive nonlinearities alongwith free space term are taken into account, oscillatory self-focusing is observed over several Rayleigh lengths. This result is in contrast to those of Sodha *et al.* (2009b). Phase exhibit peculiar behavior for different values of $n$ as it becomes positive as well as negative. Lastly, author has studied some distinct features of critical power curves for even and odd values of $n$. Substantial decrease in dimensionless beam width ($\rho_0$) as a function of $\Pi$ is also observed for higher orders of $n$. In chapter 5, the differential equation for beam width and phase is established using variational approach by investigating the propagation of cosh-Gaussian laser beams in a plasma with weakly relativistic-ponderomotive regime. It is observed that large value of $k_i'$ weakens the self-focusing effect in the absence of decentred parameter. However, oscillatory self-focusing takes place for higher value of decentred parameter, $b = 1$ and all curves are seen to exhibit sharp self-focusing effect for $b = 2$. Longitudinal phase is observed to be negative for the present investigation for different values of $k_i'$ whereas regularised phase is always negative with dimensionless distance of propagation, $\eta$. Lastly, some distinct features of critical power curves for various values of $b$ are studied.

Chapter 6 is devoted to evolution of super-Gaussian laser beam in a plasma transverse to magnetic field when relativistic nonlinearity is considered. The equation for beam width parameter $f$ using higher order paraxial ray theory is obtained. Depending on the value of $a_2$, author predicts two regimes characterized by dark and bright ring formation. It is observed that self-focusing character
becomes slow with higher value of $m$. Further, a study of some distinct features of critical power curves for varying values of $g$ for a bright ring is depicted in the form of graphs. In chapter 7, the study of interaction between two Gaussian electromagnetic beams in a plasma for weakly relativistic-ponderomotive regime is undertaken when the axes of two beams are initially parallel along $z$-axis in the $xz$ plane. Second order coupled ordinary differential equations have been obtained for the distance between centers of the beams, and the beam widths in the $x$- and $y$- directions along $z$- axis. Oscillatory self-focusing takes place in all the three cases of $\Pi$. However, there is substantial increase in self-focusing with increase in $\Pi$. It is also observed that the distance between two consecutive points of intersection of two beams increases with increase in $\Pi$. Defocusing of two beams is observed for a chosen set of parameters and the difference in the position of maximum and minimum of $f_x$ and $f_y$ increases with increasing $\xi$.

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