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PROPAGATION DYNAMICS OF ELLIPTICAL Q-GAUSSIAN LASER BEAMS IN COLLISIONAL PLASMAS WITH AXIAL DENSITY RAMP: VARIATIONAL THEORY APPROACH

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Abstract

Theoretical investigation on propagation dynamics of intense q-Gaussian laser beams propagating through collisional plasmas with axial density ramp has been presented. Emphasis is put on investigating the dynamics of beam width and axial phase of the laser beam. Effect of the ellipticity of the cross section of the laser beam also has been incorporated. Using variational theory based on Langrangian formulation nonlinear partial differential equation (P.D.E) governing the evolution of beam amplitude has been reduced to a set of coupled ordinary differential equations for the beam widths of the laser beam along the transverse directions. The evolution equation for the axial phase of the laser beam has been obtained by the Fourier transform of the amplitude structure of the laser beam from coordinates space to (k_x, k_y) space. The differential equations so obtained have been solved numerically to envision the effect of laser-plasma parameters on the propagation dynamics of the laser beam.

Keywords: q-Gaussian, Collisional Plasmas, Density Ramp

INTRODUCTION

Laser is the one of the most important scientific invention of the 20th century. When laser made its debut, it was referred to as solution in search of a problem. Today laser has become ubiquitous in consumer technology, from CD players to supermarket checkout scanners. Higher end applications of laser are also abound. This includes medical diagnostics and treatment, nuclear fusion, particle accelerators, decommissioning of explosives etc. The diversity in the applications of lasers can be felt from the fact that currently this instrument is being used for heating as well as for ultra-intense cooling. The same instrument can produce extremely hot state of matter(plasma) as well as extremely cold state of matter (Bose Einstein Condensate). The impact of laser on society has changed over time and is still changing. Already, laser have provided the preferred solution to an impressive variety of real-world situations, and it is expected that in coming years it will keep on enhancing quality of life and will contribute wealth to the world economy.

In most of the applications the laser intensity is the key parameter that decides their ultimate breath. Currently, due to the light's inherent wave property to diffract, the laser power has gotten into bottleneck at the order of few peta watts. Initially it was believed that diffraction of the laser beam can not be avoided during its propagation neither through vacuum nor through material media. However, in 1964 Chio et al (Chiao, et al., 1965) showed that in media whose index of refraction