Dynamics of the Diffraction Ray Generated During Sharp-Focusing and Self-Focusing of the Femtosecond Laser Pulse in Air

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The peculiarities of propagation of the femtosecond laser radiation under sharp-focusing and self-focusing on basis a diffraction rays and a nonlinear Schrödinger equation [1] had been researched. We performed numerical simulation for Gauss laser pulse self-focusing in air with the duration t =100 fs, initial radius R = 1 mm, and initial peak power 10 Pcr, where the value Pcr for air is 3.2 GW. Two cases of focusing, by a parabolic lens and by axicon respectively, were examined (Fig.1).

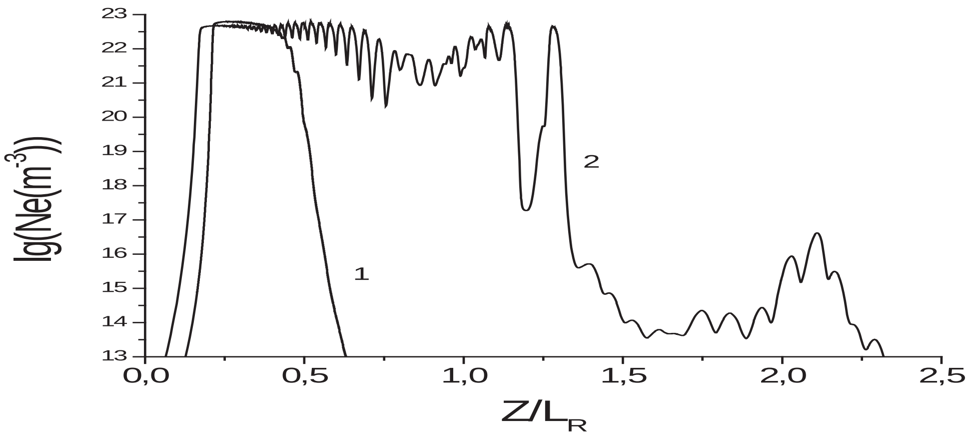

Fig. 1. The distribution of the logarithm of the electron density on the axis of the laser beam for the case of self-focusing (focal length is 0.5 Lr) for parabolic lens (1) and axicon (2). Distance of propagation normalized to the Rayleigh length-Lr.

Using as basis the diffraction rays, introduced before, the physical mechanisms of formation of the filament at different stages of its evolution had been analyzed (Fig.2 a) and (Fig.2 b). The light filament can be identified as a light beam tube [2] in the case of focusing by a parabolic lens is established. In the case of axicon the filament can not be identified as the ray tube.

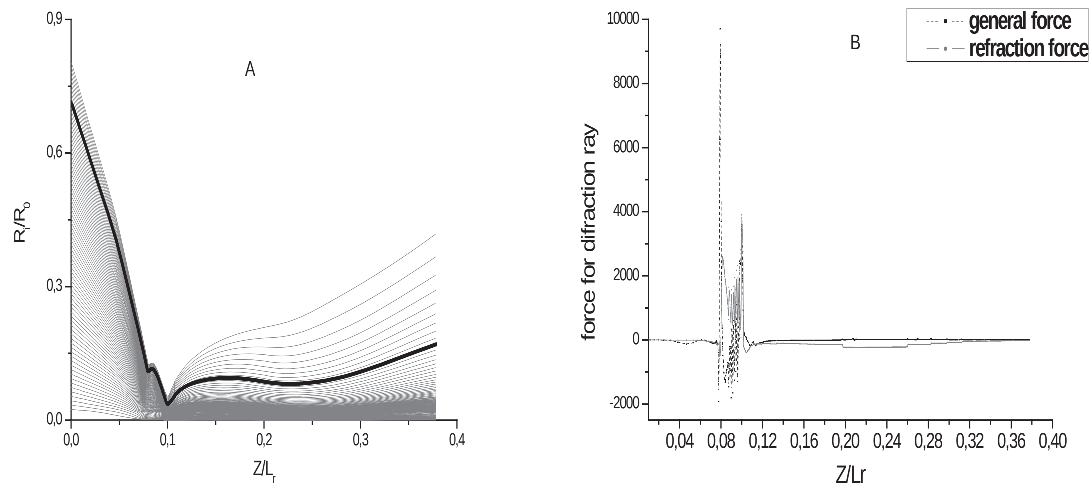

Fig. 2. On the graph (A) representation of the dynamics of the averaged diffraction ray [1] for the case of parabolic lens and sharp-focusing (focal length is 0.1 Lr). Thick curve corresponds to the boundaries of the light beam tube, and coincides with the boundaries of the filament. On the graph (B) representation of the dynamics of the general force and refraction force [1] on this light beam tube.

Diffraction forces are crucial in stopping of the collapse in all cases. Principal role of diffraction interaction between central and peripheral parts of a laser beam in formation of stable light channel near the beam axis is established.

References

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