Numerical calculation of the filamentation of femtosecond laser pulses in sapphire at interaction of two coherent beams, one of which contains a phase singularity

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Abstract

Numerical modeling and investigation of the spatial structure of the plasma channels of femtosecond laser filaments in the sapphire crystal under interaction of two coherent beams, one of which contains a phase singularity, were performed. Trajectories of the filaments and distribution of the plasma density were obtained for different angles of convergence of the beams and various time delays between pulses. The control of the filaments and their plasma channels angular and longitudinal positions was analyzed. The numerical simulations were performed on the supercomputer SRCC MSU "Chebyshev".

It was obtained the linear dependence of the critical power of self-focusing of a ring beam with a phase singularity from the topological charge m. It was shown that the phase singularity in the circular beam ensures the preservation of the circular structure at a considerable distance.

Interaction with additional crossed coherent Gaussian beam leads to several areas of constructive interference, which may result in nucleation of filaments. The case of the formation of two filaments was considered. It was shown that the trajectories of the filaments are segments of straight lines inclined at some angle to the optical axis.

The position of the filaments in crossed beams can be controlled by changing the angle of the convergence of the beams or the time delay between pulses. The time delay determines the angular position of the filaments. The longitudinal position of the filament (peak pulse power fixed) depends both on the phase difference between the beams and the angle of convergence of the beams α. The dependence of the distance to the nonlinear focus from the angle α has a non-monotonic character.