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Modeling the intense ultra-short laser pulse filamentation in air: Multiple foci and diffraction rays

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We present a fresh outlook on the problem of ultra-short laser pulse self-focusing and filamentation when propagating in air. Two well-known qualitative physical models of optical pulse filamentation scenario, the dynamic multiple focusing, and the wave-guiding models, are considered and partially revisited. In terms of the averaged (effective) laser beam radius, the filament is treated as a net product of layer-by-layer (in time) self-focusing of separate temporal pulse slices. This means that the evolution of the effective radius of every pulse temporal layer is characterized by the formation of its own local nonlinear focus at a certain point of the optical path. The sequence of local focal spots produced by individual temporal slices forms an extended beam waist of a variable diameter, which is just referred to as the light filament.

By means of the developed time-averaged diffraction ray tracking technique, the crucial role of the diffraction effects in the formation of a light filament and following a low-divergent light channel near the beam axis is revealed. As the filamentation starts, two characteristic ray families are formed in the beam: (a) the paraxial part, whose angular divergence after the exit of filamentation zone is smaller than the diffraction-limited one, and (b) the periphery part with the characteristic divergence corresponding to the divergence of the laser beam as a whole after the passage of nonlinear focus.

Biography

Yu. E. Geints has completed his Ph.D. at the age of 28 years from Tomsk State University (Russia) and postdoctoral studies from Institute of Atmospheric Optics Russian Academy of Sciences (IAO). He is the major scientific associate of the Division of Wave Propagation in IAO. He has published more than 50 papers in reputed journals and serves as a peer reviewer in many optical journals.

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