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Mathematical Modelling of the Processes of Generation, Interaction and Reduction of Optical Filaments

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The observation of white continuum in the initial moment of filamentation of powerful femtosecond laser pulses, propagating in silica glasses, as well as the filamentation without plasma channels observed in the experiments in air, forced us to look for other nonlinear mechanisms of description the above mentioned effects. The nonlinear model request to be answered to the following basic questions:

What kinds of equations describe the diffraction, the dispersion and the nonlinear propagation of broad-band (attosecond and phase-modulated femtosecond) pulses?

Which is the process that leads to asymmetrical spectrum broadening observed experimentally in direction from the infrared region to the visible region?

What kinds of mechanisms are the ones of merging and energy exchange between the filaments?

For this reason we present system of nonlinear evolution equations leading to new parametric conversion mechanism for asymmetric spectrum broadening of femtosecond laser pulses towards the higher frequencies in isotropic media [1]. This mechanism includes cascade generation with THz spectral shift for solids and GHz spectral delay for gases. The process works simultaneously with the

four-photon parametric wave mixing. The proposed theoretical model gives very good coincidence with the experimental data. In addition we demonstrate that the $3D{+}1$ generalization of this nonlinear model describes the process of reduction of the number of filaments trough two mechanisms of nonlinear interaction: attraction due to cross-phase modulation and energy exchange due to four-photon parametric wave mixing [2].

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References

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