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Dynamic modification of optical nonlinearities related to femtosecond laser filamentation in gases[1] DMITRI ROMANOV (1,3), MARYAM TARAZKAR (2,3), ROBERT LEVIS (2,3), (1) Department of Physics, (2) Department of Chemistry, and (3) Center for Advanced Photonics Research, Temple University, Philadelphia, PA — During and immediately after the passing of a filamenting laser pulse through a gas-phase medium, the nonlinear optical characteristics of the emerging filament-wake channel undergo substantial transient modification, which stems from ionization and electronic excitation of constituent atoms/molecules. We calculate the related hyperpolarizability coefficients of individual ions, and we develop a theoretical model of filament channel evolution applicable to atmospheric-pressure and high-pressure gases. The evolution is mediated by energetic free-electron gas that results from the strong-field ionization and gains considerable energy via inverse Bremsstrahlung process. The ensuing impact ionization and excitation of the residual neutral atoms/molecules proceeds inhomogeneously both inside the channel and on its surface, being strongly influenced by the thermal conduction of the electron gas. The model shows critical importance of channel-surface effects, especially as regards the effective electron temperature. The calculated spatial-temporal evolution patterns ultimately determine the transient modifications of linear and nonlinear optical properties of filament wake channels. Medium-specific estimates are made for atmospheric- and high-pressure argon, as well as for molecular nitrogen gas.

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