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Fast Shape Evolution of Laser Filaments in the Wake of Femtosecond Driving Pulse[1] DMITRI ROMANOV, (1,2), ROBERT LEVIS, (1,3) (1) Center for Advanced Photonics Research, (2) Department of Physics, (3) Department of Chemistry, Temple University, Philadelphia, PA 19122 — A theoretical model is developed for subnanosecond evolution of highly nonequilibrium, inhomogeneous free-electron gas in a laser filament/microfilament wake channel. The evolution is driven by two interrelated mechanisms: (i) impact ionization of residual neutral atoms inside the channel and on its surface, and (ii) thermal conduction in the electron gas. The simulation results for the cases of weak and moderate initial ionization show crucial importance of incorporating the spread effects, especially as regards the electron temperature. The calculated evolution patterns determine the transient optical and electronic properties of filament wake channels. Accordingly, we propose tracing the wake channel evolution via linear and nonlinear light-scattering experiments. The evolving shape of the electron density distribution can be extracted from longitudinal and/or transverse Fraunhofer diffraction patterns. Complementarily, the evolving temperature distribution may be deduced either from angular-resolved four-wave-mixing experiments or from the spatial-spectral patterns of giant Rabi sidebands. Medium-specific estimates are made for atmospheric-pressure argon gas. In molecular-gas cases, the model can be straightforwardly augmented to incorporate the processes of dissociative recombination and vibrational excitations.

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