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**Applications of Electron Avalanche: Sensing Individual Electrons and Nonlinear Laser Self-Guiding**[1] D. WOODBURY, R. M. SCHWARTZ, E. ROCKAFELLOW, A. GOFFIN, H. M. MILCHBERG, University of Maryland, College Park — Electron avalanche ionization drives an exponential electron growth of electron density in background gases starting from a single electron seed, analogous single photon detection in a photomultiplier tube. Here we present two applications of electron avalanche driven by mid-IR and long-wave-IR (LWIR) lasers, which minimize the competing process of multiphoton ionization. In the first case, we used a picosecond mid-IR driver to experimentally measure ultralow electron densities from both radiation and femtosecond laser ionization over 14 orders of magnitude (from $10^3$ to $10^{17}$ $cm^{-3}$). The picosecond pulse length limits electron diffusion to create discrete, countable breakdown sites around initial electron seeds, and thus enables highly accurate initial density measurements. For the second application, we discovered a new avalanche based mechanism for self-guided propagation of high power LWIR pulses in ambient air. We present a new simulation approach that incorporates the nonlinear response of an ensemble of spatially discrete and dynamic avalanche breakdown sites into a continuum propagation model, and demonstrate that avalanche ionization from aerosols leads to moderate intensity, long-range self-guiding of LWIR, few picosecond pulses in a large channel.

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