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Optical Breakdown Based on Resonant Enhanced Multi-Photon Ionization and Electron Avalanche Ionization in Gas Mixtures MIKHAIL SHNEIDER, ZHILI ZHANG, RICHARD MILES, Princeton University — We present the results of the experimental and theoretical study of a new kind of optical breakdown in gases with ionization amplification by the combination of Resonant Enhanced Multi-Photon Ionization (REMPI) and subsequent avalanche ionization. As an example, the Ar:Xe mixture was studied. Coherent microwave Rayleigh scattering (radar REMPI) was used to measure REMPI and avalanche ionization. It was shown that REMPI ionization of a relatively small density component (Ar) can catalyze the avalanche ionization process in a buffer gas (Xe) by the use of a laser beam at very low intensity. Theoretical plasma dynamic model verifies the finding. Based on the presented results, several important applications are possible. First, it can improve the detection sensitivity of Radar REMPI. Second, it suggests that plasma generation can be achieved at reduced gas densities or laser beam intensities. Here we can suggest the following two methods: 1. Long laser pulse: The pulse front generates REMPI and subsequent pulse initiates avalanche ionization and Joule heating. 2. Two subsequent laser pulses: A short laser pulse tuned on a REMPI of mixture component generates weakly ionized REMPI plasma and a long off-resonant laser pulse for the avalanche ionization and Joule heating.

Mikhail Shneider
Princeton University

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