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Nonlinear atomic response to intense, ultrashort x rays GILLES DOUMY, Argonne National Laboratory, SANG-KIL SON, CFEL - DESY, CHRISTOPH ROEDIG, COSMIN IOAN BLAGA, ANTHONY DICHIARA, The Ohio State University, ROBIN SANTRA, CFEL-DESY, MARC MESSERSCHMIDT, CHRISTOPH BOSTEDT, JOHN BOZEK, LCLS - SLAC, PHILIP BUCKSBAUM, JAMES CRYAN, JAMES MIKE GLOWNIA, SHAMBHU GHIMIRE, PULSE-SLAC-Stanford, LI FANG, MATTHIAS HOENER, NORA BERRAH, Western Michigan University, ELLIOT KANTER, BERTOLD KRAESSIG, Argonne National Laboratory, DAVID REIS, PULSE -SLAC - Stanford, NINA ROHRINGER, Lawrence Livermore National Laboratory, LINDA YOUNG, Argonne National Laboratory, PIERRE AGOSTINI, LOUIS DIMAURO, The Ohio State University — The nonlinear absorption mechanisms of neon atoms to intense, femtosecond *kilovolt* x rays are investigated. The production of Ne^{9+} is observed at x-ray frequencies below the Ne^{8+}, $1s^2$ absorption edge and demonstrates a clear quadratic dependence on fluence. Theoretical analysis shows that the production is a combination of the 2-photon ionization of Ne^{8+} ground state and a high-order sequential process involving single-photon production and ionization of transient excited states on a time-scale faster than the Auger decay. We find that the nonlinear direct two-photon ionization cross-section is orders of magnitude higher than expected from previous calculations.

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