Optical field ionization of atoms and ions using ultrashort laser pulses

United States. Dept. of Energy ;
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1993

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Monografía

This dissertation research is an investigation of the strong optical field ionization of atoms and ions by 120-fs, 614-run laser pulses and 130-fs, 800-nm laser pulses. The experiments have shown ionization that is enhanced above the predictions of sequential tunneling models for He{sup +2}, Ne{sup +2} and Ar{sup +2}. The ion yields for He{sup +l}, Ne{sup +l} and Ar{sup +l} agree well with the theoretical predictions of optical tunneling models. Investigation of the polarization dependence of the ionization indicates that the enhancements are consistent with a nonsequential ionization mechanism in which the linearly polarized field drives the electron wavefunction back toward the ion core and causes double ionization through inelastic e-2e scattering. These investigations have initiated a number of other studies by other groups and are of current scientific interest in the fields of high-irradiance laser-matter interactions and production of high-density plasmas. This work involved: (1) Understanding the characteristic nature of the ion yields produced by tunneling ionization through investigation of analytic solutions for tunneling at optical frequencies. (2) Extensive characterization of the pulses produced by 614-nm and 800-ran ultrashort pulse lasers. Absolute calibration of the irradiance scale produced shows the practicality of the inverse problem--measuring peak laser irradiance using ion yields. (3) Measuring the ion yields for three noble gases using linear, circular and elliptical polarizations of laser pulses at 614-nm and 800-nm. The measurements are some of the first measurements for pulse widths as low as 120-fs

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Editorial: Washington, D.C. United States. Dept. of Energy Oak Ridge, Tenn. Distributed by the Office of Scientific and Technical Information, U.S. Dept. of Energy 1993

Descripción física: 156 pages digital, PDF file

Nota general: Published through the Information Bridge: DOE Scientific and Technical Information 12/01/1993 "Ucrl-lr--115496." "DE94006643." Fittinghoff, D.N.

Tesis: Thesis (Ph. D.); Dec 1993

Restricciones de acceso: Use copy. Restrictions unspecified star. MiAaHDL

Financiación: W-7405-ENG-48

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Materia: Atomic And Molecular Physics

Entidades: Lawrence Livermore National Laboratory. res Estados Unidos. Department of Energy. spn Estados Unidos. Department of Energy. Office of Scientific and Technical Information. dst

Enlace a formato físico adicional: Original (OCoLC)34007467
