



Optical field ionization of atoms and ions using ultrashort laser pulses

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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 $\text{He}^{\text{sup } +2}$, $\text{Ne}^{\text{sup } +2}$ and $\text{Ar}^{\text{sup } +2}$. The ion yields for $\text{He}^{\text{sup } +1}$, $\text{Ne}^{\text{sup } +1}$ and $\text{Ar}^{\text{sup } +1}$ 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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