BULLETIN

OF THE AMERICAN PHYSICAL SOCIETY

42nd Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics

June 13–17, 2011
Atlanta, Georgia

DAMOP

Volume 56, Number 5

APS physics

L1 145 Probing electron recombination in atomic clusters excited by intense X-Ray fields IONUT GEORGESCU, *University of California, Irvine* Shining an intense x-ray laser on large molecules and atomic clusters produces a large number of photo-electrons which leave the cluster in a highly charged state, leading to its Coulomb explosion. However, not all photo-electrons are able to leave. Some will be trapped in the cluster potential and will form a nano-plasma, slowing down the expansion and contributing to the optical response of the cluster. X-Rays couple to core electrons and the holes created via photo-ionization can relax via Auger decays, which heat up the plasma and accelerate the expansion on the one side, and repopulate the core levels for further ionization on the other side. Simulations for large Argon clusters (N = 923,2869) at current FEL parameters (1.5 keV, 5 fs, 100 μJ) have shown that collisional ionization and field fluctuations in the plasma can stop this chain reaction very early in the process by removing valence electrons. The expansion is slowed down and the core holes survive for very long times, their decay providing a probe of the electron recombination during the cluster expansion.

L1 146 Double ionization of O_2 via single photon at energy below double ionization threshold I.A. BOCHAROVA, C. STUCK, M. SCHOEFFLER, A. BELKACEM, TH. WEBER, *LBNL* R. DOERNER, T. JAHNKE, *University of Frankfurt* A. LANDERS, *Auburn University* C.L. COCKE, *Kansas State University* We studied the double ionization of O_2 molecule at photon energies below the double ionization threshold (about 41.5 eV). At this energy the double ionization is a two-step process. A highly excited cation state is produced by the interaction of the neutral molecule with the photon. The cation autoionizes subsequently. We try to elucidate the dissociative intermediate states of this singly charged ion during this double ionization processes. Therefore we performed a kinematically complete experiment measuring the 3d-momentum vectors of two electrons and two oxygen ions in coincidence following the excitation of O_2, dissociation of O_2^+ and the subsequent autoionization of the excited neutral oxygen atom. We present the ionic kinetic energy release as a function of electron energies (energy maps), electron angular distributions in the body fixed frame and compare our results to previous time-resolved studies.

[1]A. Sandhu et al., Science, 322, 1081, (2008).

L1 147 Dielectric response effects in time-resolved photoemission from metal surfaces* CHANG-HUA ZHANG, UWE THUMM, *Kansas State University* We investigate dielectric response effects in attosecond time-resolved photoelectron (PE) spectra from metal surfaces [1]. We model the response of the metal due to excitation of bulk and surface plasmons by the creation and propagation of the PE in terms of an effective potential that depends on the velocity of the PE. Using this dynamical image potential, we calculate IR-streaked XUV-photoemission spectra and compare them with spectra obtained with the corresponding *static* image potential. We find a significant relative temporal shift [2] in photoemission from the conduction band for calculations with static and dynamical image potentials. We further analyze the dependence of this relative shift on the XUV frequency as well as on solid-state characteristics, such as the bulk plasmon frequency, the IR skin depth, and the PE transport in the solid [3].

*Supported by the NSF and DOE.

[1]C.-H. Zhang and U. Thumm, Phys. Rev. Lett. 102, 123601 (2009); Phys. Rev. A 80, 032902 (2009).
[2]C.-H. Zhang and U. Thumm, Phys. Rev. A 82, 043405 (2010).
[3]C.-H. Zhang and U. Thumm, Dielectric response effects in attosecond time-resolved streaked photoelectron spectra of metal surfaces, submitted.

L1 148 Monochromatic X-Ray Irradiation of High-Z Atoms and Nanoparticles for Biomedical Applications SARA LIM, A. PRADHAN, S. NAHAR, E. CHOWDHURY, *Ohio State U* Y. YU, K. HUANG, K. YAN, *Thomas Jefferson U* We will report theoretical and experimental studies of resonant X-ray interaction with heavy elements for potential applications to cancer diagnsotics and therapy. The resonant transitions may be targeted with monochromatic X-ray sources, such as synchrotron photon beams and high-intensity pulsed lasers [1] following a deep inner-shell ionization. X-rays from conventional machines in medical use are broadband with filtered bremsstrahlung spectrum. This is very ineffcient as low-energy X-rays are absorbed without much penetration and high-energy x-rays pass through without much interaction. Calculations of Auger cascades and K-shell resonance positions [2] show that monochromatic beams may be employed to optimize localized energy deposition in high-Z nanomaterials embedded, e.g. in a cancerous tumor. Theoretical results for several elements from bromine (Z = 35) to gold (Z = 79) and experimental studies for partial conversion of bremsstrahlung spectrum from conventional X-ray sources into K-alpha radiation for imaging and/or therapeutics will be reported.

[1]Pradhan *et al.*, J. Phys. Chem. A 113, 12356 (2009).
[2]Nahar *et al.*Can. J. Phys. (in press)- Partial Support: DOE

L1 149 Plasma generation by chirped ultrashort laser pulses JEREMY GULLEY, *Kennesaw State University* Current models of ultrafast-laser induced ionization in dielectric materials typically assume that the ultrashort pulse is (at least approximately) monochromatic. However, in recent years it has been demonstrated both computationally and experimentally that material damage by ultrashort laser pulses significantly depends on the chirp of the pulse in question. Here we present results from a recent study that explores this problem using simulations of laser-induced ionization in dielectrics where free-carrier generation is sensitive to the instantaneous frequency of the laser pulse. It is demonstrated that plasma generation by initially unchirped pulses is not immune from this chirp-dependence since nonlinear optical effects, such as supercontinuum generation, significantly chirp the pulse as it propagates.

L1 150 Numerical study of Penning-Malmberg-Surko positron trap efficiency SRDJAN MARJANOVIC, MILOVAN SUVAKOV, ANA BANKOVIC, ZORAN LJ. PETROVIC, *Institute of Physics, Pregrevica 118, POB 68, 11000 Belgrade* Efficiency of a gas filled positron trap can be improved in two ways: by shortening the operation time required to thermalize the particles in the trap, and by increasing the percentage of particles trapped. We examine both techniques by a well tested Monte Carlo code, and give an overview of the loss processes involved. Temporal and spatial evolution of the energy distribution of particles allows us to show gradual transition of a beam into a swarm of particles. The model trap is a classic three stage potential well design using N_2 as a buffer gas in the first two stages and a N_2/CF_4 mixture in the third. It was found that including cross sections for rotational e^+-N_2 excitation is essential to achieve final stages of thermalization. Various trap implementations use different sources and moderators, and depending on the properties of the incoming beam, the trap itself can be optimized by changing its attributes (buffer gas pressures, dimensions of the