

SESSION P2: STUDIES WITH SPECIAL ATOMS AND MOLECULES

Friday morning, 18 May 2001

Salon A, London Convention Centre at 8:00

Eric Hessels, York University, presiding

8:00

P2 1 Multiphoton Dissociation of MgC_{60}^+ complexes X. ZHAO, V. RYJKOV, H.A. SCHUESSLER, *Dept. of Physics, Texas A&M University, College Station, TX 77843-4242* R.I. THOMPSON, *Dept. of Physics, University of Calgary* We have studied the production of MgC_{60}^+ complexes via Mg^+ with C_{60} collisions, and have investigated the resulting complexes by optical spectroscopy and ion trap mass spectrometry. The experiment was carried out in a linear ion trap in high vacuum under conditions of controlled collision energies, reactant densities, and low buffer gas pressure. Laser-induced photodissociation was also used to identify their molecular structure. Pure samples of both exohedral and endohedral magnesium fullerenes were produced. Photodissociation cross sections were measured. The ion trap setup is well suited to form and study the structure of unusual fullerene complexes. Supported by ARP grant No. 10366-82.

8:12

P2 2 Prediction of sharp ionization features in microwave-driven hydrogen Rydberg atoms THOMAS CLAUSEN, REINHOLD BLUMEL, *Wesleyan University, Department of Physics, Science Tower, 265 Church Street, Middletown, CT-06459* Motivated by early investigations on probability transport in periodically kicked and smoothly driven quantum systems we conjecture that sharp ionization features should exist in the ionization curves of microwave-driven hydrogen Rydberg atoms. We substantiate our prediction by detailed model calculations of one- and three-dimensional microwave-driven hydrogen Rydberg atoms.

8:24

P2 3 Enhanced Avalanche Ionization by RF Fields Creating an Ultracold Plasma M.P. ROBINSON, T.F. GALLAGHER, *University of Virginia* B. LABURTHE TOLRA, P. PILLET, *Laboratoire Aime Cotton, CNRS II Campus d'Orsay* Ultracold plasmas have been shown to evolve from initially frozen Rydberg gases held in magneto-optical traps.¹ We report the enhancement of the avalanche ionization process by application of radiofrequency fields. An initial slow ionization rate is observed in the Rydberg sample due to black body ionization and ionizing collisions with hot Rydberg atoms. This produces an overall positive space charge of cold ions as the hot electrons leave the sample. Once a threshold density of positive charges is built up, the hot electrons become trapped to the sample, leading to avalanche ionization due to electron-Rydberg collisions. The mechanism of the ionization remains unclear. However, the application of radiofrequency fields, in the 1 V/cm, 100 MHz range, dramatically enhances the rate of avalanche ionization without changing the threshold density at which it occurs. Apparently, the limiting parameter is the rate of collisional ionization of Rydberg atoms by electrons.

¹M.P. Robinson, B. Laburthe Tolra, Michael W. Noel, T.F. Gallagher, and P. Pillet, *Phys. Rev. Lett.* **85**, 4466 (2000)

8:36

P2 4 Resonant Enhancement of Dielectronic Recombination in Linearly and Circularly Polarized Microwave Fields VICTOR KLIMENKO, T.F. GALLAGHER, *Department of Physics, University of Virginia, Charlottesville, VA 22901* We have observed dielectronic recombination (DR) of Ba^+ and e^- from a continuum of finite bandwidth in linearly polarized (LP) and circularly polarized (CP) 8 GHz microwave (MW) fields with amplitudes up to 7 V/cm. In Ba Rydberg atoms DR proceeds through $6pnl$ auto-ionizing states, where n, l are the outer electron's principal and orbital angular momentum quantum numbers. Recently we observed the effect of resonant enhancement of DR in LP MW field for those n for which MW frequency matched the spacing between n and $n+1$, n and $n+2$, etc. states (Victor Klimenko and T.F. Gallagher, *PRL* **85**, 3357 (2000)). In the present work we extended our studies to CP MW field, as well as LP MW and static electric field combined. CP MW field produced larger resonant enhancement of DR than LP MW field, while the presence of a static electric field increased the enhancement produced by LP MW field alone. Also we observed a two-photon resonant enhancement of DR in CP MW field.

8:48

P2 5 Probing the Momentum Distribution of Continuum Wavepackets Using Electron - Ion Recombination* J.G. ZEBEL, R.R. JONES, *Physics Department, University of Virginia, Charlottesville, VA 22904-4319* We have used ultrashort, nearly unipolar "half cycle" electric field pulses (HCPs) as a tool to measure the time-dependent momentum distribution of electrons in a Stark induced continuum. Ca atoms in an external field are excited from the ground state into an intermediate $4s4p$ state with a nanosecond dye laser. A 1 ps laser pulse with a bandwidth of approximately $20cm^{-1}$ promotes the $4s4p$ atoms to the field induced continuum, with an energy just above the saddle point in the Stark potential. At a variable time delay Δt following the excitation of the continuum wavepacket, the system is exposed to a HCP which imparts a non-zero linear momentum "kick." The portion of the probability distribution moving antiparallel to the applied kick suffers a reduction in its total energy. The fraction of probability amplitude whose energy is below the saddle-point forms a bound wavepacket. Because the recombination probability depends on the kick strength and distribution of momentum along the kick direction, the time-dependent momentum distribution of the continuum wavepacket can be recovered from measurements of recombination probabilities versus kick strength and time delay Δt .

*Supported by the AFOSR and the Packard Foundation

9:00

P2 6 Ponderomotive Optical Lattices for Trapping Rydberg Atoms JEFFREY R. GUEST, SUBRATA K. DUTTA, ALISA WALZ-FLANNIGAN, DAVID FELDBAUM, GEORG RAITHEL, *Department of Physics, University of Michigan, Ann Arbor, MI* Recent experiments have generated cold Rydberg atoms by optically exciting cold ground state atoms; however, subsequent trapping of these atoms has not been demonstrated. We propose a method to trap highly-excited Rydberg atoms in an optical lattice by taking advantage of the weakly-bound nature of