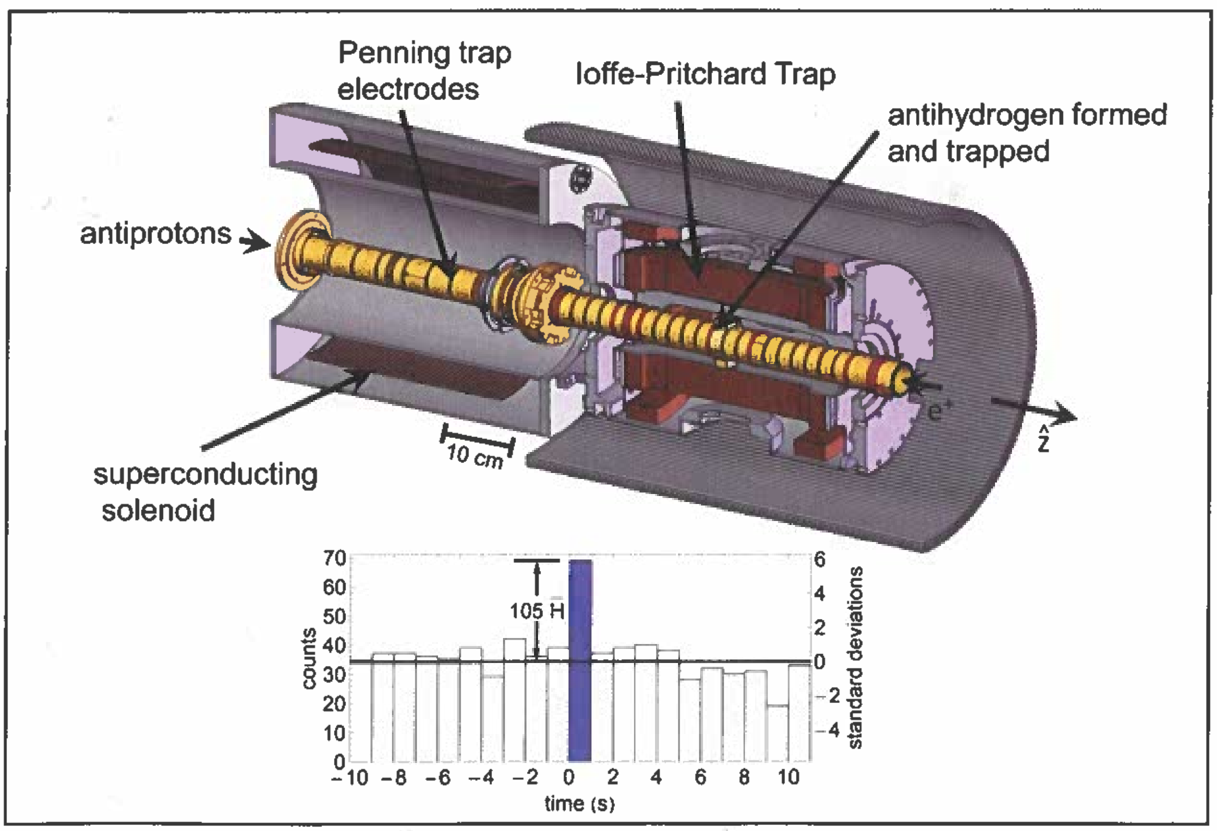
BULLETIN

OF THE AMERICAN PHYSICAL SOCIETY

43rd Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics

June 4–8, 2012

Anaheim, California



Volume 57, Number 5

$^1D^e$ and $^1F^o$ (n = 10 to 20) doubly-excited resonance states of He atoms. In addition, we present the first theoretical prediction of the energies and widths of high-lying doubly-excited resonance states of $^1P^o$ (n=8-15) in external dc electric field strengths of 3.915-10.44 kV/cm. The calculated dc-field perturbed high-lying resonance energies are in good agreement with the latest experimental data.

*This work was partially supported by DOE and NSF and by MOE-NTU-Taiwan.

Q1 11 Landau-Zener crossings in magnetically trapped polar molecules* BENJAMIN STUHL, MARK YEO, MATT HUMMON,[†] JUN YE, *JILA / University of Colorado and NIST* Paramagnetic polar molecules generically exhibit a number of avoided crossings between Zeeman manifolds of opposite parities in combined magnetic and electric fields. In the context of a magnetic trap, these avoided crossings become opportunities for molecules to Landau-Zener hop to untrapped states. We have observed this behavior in a model system, magnetically trapped OH and achieve near-quantitative agreement with a simple Landau-Zener theory.

*We acknowledge funding from the AFOSR-MURI on Cold Molecules and the NSF.

†M. H. is a National Research Council postdoctoral Fellow.

Q1 12 PHOTON INTERACTIONS WITH ATOMS, IONS, AND MOLECULES III

Q1 13 THE IRON PROJECT & THE IRON OPACITY PROJECT: Re-establishing the Sun as the Astrophysical Rósetta Stone* ETHAN PALAY, SULTANA NAHAR, ANIL PRADHAN, MARC PINNSONOAULT, *Ohio State U* JAMES BAILEY, *Sandia Natl Lab* The aims of the two projects are detailed studies of radiative and collisional processes of astrophysically abundant atoms and ions, mainly iron and iron-peak elements, over a wide energy range, from infra-red to X-rays. One of the most fundamental astrophysical problem today is the discrepancy in the abundances of the most common volatile elements C, N, O, Ne, etc in the sun. These have been spectroscopically measured to be up to 50% lower than the canonical abundances long employed in stellar interior models. A potential solution to this problem is if stellar opacities are at least 30% higher, given the inverse but complex relationship between opacities and abundances. We report on new iron opacity calcultions, including hitherto neglected atomic physics of resonances which are largely treated as lines in existing opacities calculations. We also describe recent laboratory experiements of monochromatic opacities at the Sandia Z-pinch device. We will present Breit-Pauli R-matrix results for Fe VIII with 567 fine structure levels with n $\leqslant 10$, $l \leqslant 9$, and $0.5 \leqslant J \leqslant 9.5$, and 35,504 electric dipole allowed fine structure transitions. Results for forbidden transitions will also be presented.

*Partial support: NSF, DOE

Q1 14 Enhancement of X-ray dose absorption for medical applications SARA LIM, *Ohio State University* MAXIMILIANO MONTENEGRO, *Universidad Catolica de Chile* SULTANA NAHAR, ANIL PRADHAN, ROLF BARTH, ROBIN NAKKULA, ERICA BELL, *Ohio State University* YAN YU, *Thomas Jefferson University* Interaction of high-Z (HZ) elements with X-rays occurs efficiently at specific resonant energies. Cross sections for photoionization rapidly decrease after the K-edge; higher energy X-rays are mostly Compton-scattered. These features restrict the energy range for the use of HZ moities for radiosensitization in cancer therapy. Conventional X-ray sources such as linear accelerators (LINAC) used in radiotherapy emit a broad spectrum up to MeV energies. We explore the dichotomy between X-ray radiotherapy in two ranges: (i) E < 100 keV including HZ sensitization, and (ii) E > 100 keV where sensitization is inefficient. We perform Monte Carlo numerical simulations of tumor tissue embedded with platinum compounds and gold nanoparticles and compute radiation dose enhancement factors (DEF) upon irradiation with 100 kV, 170 kV and 6 MV sources. Our results demonstrate that the DEF peak below 100 keV and fall sharply above 200 keV to very small values. Therefore most of the X-ray output from LINACs up to the MeV range is utilized very inefficiently. We also describe experimental studies for implementation of option (i) using Pt and Au reagents and selected cancer cell lines. Resultant radiation exposure to patients could be greatly reduced, yet still result in increased tumoricidal ability.

Q1 15 Inner shell resonances in the outer shell photoionization of Xe@C60 MIRON AMUSIA, *Racah Institute of Physics, Hebrew University, Jerusalem, Israel* LARISSA CHERNYSHEVA, *Ioffe Physical-Technical Institute, St.-Petersburg, Russia* Fullerenes C_{60} can be stuffed by almost all atoms A or even simple molecules. It is demonstrated by the example of the 5p-subshell of the Xe atom stuffed inside the C_{60} fullerene, i.e. the endohedral Xe@C_{60} that the so-called confinement resonances in 4d subshell strongly affect the absolute and differential in the photoelectron emission angle cross-section of 5p electrons photoionization in the region of 4d ionization threshold. It is a sort of a surprise that the narrow inner shell resonances are not smeared out in the outer shell photoionization cross-section. Inner shell resonances affect the outer cross-section by enhancing this enormously and modifying 5p dipole and non-dipole angular anisotropy parameters. Close to its own photoionization threshold, 5p photoionization cross-section of Xe@C_{60} is dominated by its own confinement resonances greatly enhanced by the intensity of incoming radiation due to polarization of the C_{60} electron shell by the incoming photon beam. In between, the 4d and 5p thresholds, the effect of 4d is becoming stronger while own resonances of 5p are becoming less and less important.

Q1 16 MEMS-Based Beam Steering for Individual Addressing of Trapped Ions STEPHEN CRAIN, EMILY MOUNT, CALEB KNOERNSCHILD, TAEHYUN KIM, SOYOUNG BAEK, PETER MAUNZ, JUNGSANG KIM, *Fitzpatrick Institute for Photonics, Electrical and Computer Engineering Department, Duke University* The ability to address individual ions in a long linear chain with multiple beams is necessary in order to realize scalable quantum information processing with trapped ions. Microelectromechanical systems (MEMS) technology allows one to design movable micromirrors to focus laser beams on individual ions and steer the focal point in two dimensions. This system provides low optical loss across a broad wavelength range and can easily scaled to multiple beams. Our current MEMS system is designed to steer a far-detuned UV pulsed laser beam to carry out single and two qubit Raman gates on a chain of Yb ions, with a waist of 1.5 μm across a 20 μm range. The crosstalk between neighboring ions can be used to characterize the individual addressing fidelity in this setup. We also present a