

# SYMPOSIUM ON UNDERGRADUATE RESEARCH

*Division of Laser Science of A.P.S - LS XXIII - 17 September 2007 - San Jose CA*

## LUNCH AND POSTER SESSION

**We will serve a complimentary lunch in the Fairfield Room for all symposium participants.**

**This is a wonderful opportunity to make contacts and get to know one another.**

**Session SMA (poster): 12:00 - 1:55 PM, John Noé, Presider**

**SMA1 - Progress Towards Parity Nonconservation Measurements in Atomic Ytterbium, A. Family<sup>1</sup>, K. Tsigutkin<sup>1</sup>, J.E. Stalnaker<sup>1</sup>, V.V. Yashchuk<sup>2</sup>, D. Budker<sup>1,3</sup>, 1) Department of Physics, University of California, Berkeley, CA 94720-7300 2) Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley CA 94720, 3) Advanced Light Source Division, Lawrence Berkeley National Laboratory, Berkeley CA 94720.** Our experiment is aimed at measurements of atomic parity nonconservation (PNC) effects in the  $^1S_0$ - $^3D_1$  transition (408 nm) in atomic Ytterbium (Z=70). Such an experiment will determine differences in PNC effects between different hyperfine components for odd-neutron-number Yb isotopes and, thereby, will allow measurements of the nuclear anapole moment.

**SMA2 - Investigation of the Properties of Composite Optical Vortices, Sean Baumann, Enrique Galvez, Colgate University, Hamilton, NY 13346.** We construct an interferometer to collinearly interfere two Laguerre-Gauss beams of varying topological charges. We then observe the changing vortex structure as a function of relative intensity, or of the relative Gouy phase shifts as the beams pass through a long focal length lens. Supported by the Research Corporation.

**SMA3 - Liquid Dynamics on Functionalized Silica as Studied by Contact Angle Analysis and Optical Kerr Effect Spectroscopy, Pearl Horng, Mike Brindza, Qin Zhong, John T. Fourkas, Univ. Maryland, College Park, MD 20742.** Solid/liquid interactions can strongly influence the structure and dynamics of molecular liquids. By comparing the wetting properties of liquids on functionalized silica and using ultrafast Optical Kerr Effect spectroscopy to determine their orientational diffusion constants, we seek to understand the relationship between structure and dynamics at solid/liquid interfaces. Supported by NSF.

**SMA4 - Correlation Measurements in a Cavity QED System, Eric Cahoon, Rebecca Olsen, Jetai Jing, Luis Orozco, University of Maryland, College Park, MD 20742.** Auto- and cross-correlations can be used to probe the entanglement between the driven and undriven cavity modes of the system.  $^{85}\text{Rb}$  is used, cooled by means of a magneto-optical trap (MOT) and delivered to the cavity via a low-velocity intense source (LVIS) setup. Supported by NSF.

**SMA5 - Higher Order Laser Modes in Elliptical Cylindrical Coordinates, Adam Goldstein, Matthew Johnson, and Reeta Vyas, University of Arkansas, Fayetteville, AR 72701.** We study the variations in transverse intensity profiles of Ince-Gaussian beams, which are higher order laser beams and are an orthogonal and complete set of solutions to the paraxial wave equation in elliptic cylindrical coordinates. Supported by NSF-REU.

**SMA6 - Schaefer-Bergmann Patterns in Acousto-Optic Devices, Daniel J. D'Orazio<sup>1</sup>, Martin Cohen<sup>2</sup>, John Noé<sup>2</sup>, 1) Juniata College, Huntingdon, PA 16652, 2) Stony Brook University, Stony Brook, NY 11794.** Complex spatial patterns were unexpectedly observed in the output of commercial acousto-optic devices. These patterns, called Schaefer-Bergmann patterns, are investigated to determine their origin and thus the behavior of acoustic waves in the acousto-optic crystal. A theoretical model predicting pattern shapes based on the crystal's elastic constants is developed. Supported by NSF-REU.

**SMA7 - Spontaneous Parametric Down Conversion using two contacted  $\beta$ -Barium Borate Crystals, Aleks Klimas, Daniel Gauthier, Kyle McKay, Joel Greenburg, Andrew Dawes, Duke University, Durham NC 27708.** We investigate spontaneous photon down conversion in a pair of optically-contacted  $\beta$ -barium borate crystals that were cut incorrectly. We quantify the manufacturing errors by measuring the photon number distribution in the far-field as a function of crystal tilt and rotation angle. Supported by Duke Physics Advanced Laboratory Endowment.

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**SMA8 - Magneto-Optical Trapping of  $^{87}\text{Rb}$** , *Gennady Malyshev, John R. Brandenberger; Lawrence University, Appleton, WI 54911.* A magneto-optical trap for  $^{87}\text{Rb}$  has been designed and constructed. This work sets the stage for further optimization of cloud location, trap depth, the number of trapped atoms and imaging of the MOT. Supported by the Keck Foundation.

**SMA9 - Investigation of Notchless In situ  $\mu$ -Raman Spectroscopy**, *J. Cox, M. Ramme, T. Anderson, M. Richardson, CREOL, University of Central Florida, Orlando, FL 32816.* This project was to develop a  $\mu$ -Raman spectrometer system that doesn't need expensive notch filters. Ultimately this technique will be used *in situ*. The project employs a very narrow bandwidth laser to obtain the data. Thus the necessity of the notch filter is bypassed in detecting Raman scattering.

**SMA10 - EUV Energy Detector**, *Reuvani Kamtaprasad, Martin Richardson, Kazutoshi Takenoshita; University of Central Florida, Orlando, FL 32816.* We will discuss the development and experimentation of the EUV Energy Detector, designed to measure absolute in-band EUV energy emitted from a plasma source. The EUV Energy Detector is examined and compared to the Flying Circus, the community proven instrument for estimating the effective conversion efficiency of a EUV source. Supported by NSF-REU.

**SMA11 - Magnetic Slowing of a Supersonic Beam of Metastable Neon**, *Edvardas Narevicius<sup>1</sup>, Christian G. Parthey<sup>1</sup>, Adam Libson<sup>1</sup>, Isaac Chavez<sup>1</sup>, Bree Guerra<sup>1</sup>, Uzi Even<sup>2</sup>, and Mark G. Raizen<sup>1</sup>, 1) University of Texas at Austin, Austin, TX 78712, 2) Tel Aviv University, Tel Aviv 69978, Israel.* A supersonic beam of metastable neon is passed through sequentially pulsed electromagnetic coils, slowing low field seeking states. This method allows stopping and trapping at mK temperatures for all paramagnetic atoms and molecules. We plan to trap atomic hydrogen isotopes for precision spectroscopy and future studies of tritium beta decay. Supported by NSF.

**SMA12 - Circular Dichroism-Second Harmonic Generation of Si(100)**, *Galan Moody, Alan D. Bristow, Steven T. Cundiff, JILA, University of Colorado and National Institute of Standards & Technology, Boulder, CO 80309.* Circular dichroism-second harmonic generation determines interferences between bulk or surface contributions of the second order nonlinearity. Here, we report measurements on Si(100) and extract the surface dipole and bulk quadrupole contributions. Initial low-temperature data are also presented. Supported by NSF.

**SMA13 - Frequency Shifts in Diode Lasers due to Rotated Optical Feedback**, *Haley Bunting and David W. Sukow, Washington and Lee University, Lexington, VA 24450.* Experiments show that delayed, polarization-rotated feedback causes optical frequency shifts in VCSELs and edge-emitting lasers. The standard mathematical model must be modified to reproduce these effects theoretically. Supported by NSF CAREER Award #0239413.

**SMA14 - Non-Confocal Fabry-Perot Resonator**, *Thien An Nguyen, Claire Shean, Jason Reeves, Harold Metcalf, Stony Brook University, Stony Brook, NY 11794-3800.* Fabry-Perot resonators (FP) can monitor spectral purity of a single frequency beam. The degree to which the FP monitors/analyzes the beam is dependent on its FSR. For a non-confocal FP,  $\text{FSR} = c/2L$  while it is  $c/4L$  for the confocal FP. The transition from  $c/2L$  to  $c/4L$  is discussed. Supported by ONR and NSF.

**SMA15 - The Creation and Alteration of 2D MOTs**, *Eric Duchon<sup>1</sup>, Frank Moscatelli<sup>1</sup>, Eun Oh<sup>2</sup>; 1) Swarthmore College, Swarthmore, PA 19081, 2) Naval Research Laboratory, Washington, DC 20375.* Two ring-shaped permanent magnets replace traditional Anti-Helmholtz coils to create a macroscopic ring-shaped magnetic field null appropriate for a MOT. Using numerical techniques, we found that additional electromagnetic coils distort or fragment the null, with possible applications for cold atom sensors. Supported by Swarthmore College.

**SMA16 - State-Resolved Reactive Scattering by Slice Imaging: A New View of the  $\text{Cl} + \text{C}_2\text{H}_6$  Reaction**, *Wen Li, Cunshun Huang, Mohit Patel, Delon Wilson and Arthur Suits, Wayne State University, Detroit, MI 48202.* We present state-resolved crossed beam scattering results for the reaction  $\text{Cl} + \text{C}_2\text{H}_6 \rightarrow \text{HCl} + \text{C}_2\text{H}_5$ , obtained using sliced ion imaging. The results show significant coupling of the translational energy and angular distributions, and these vary substantially with detected HCl quantum state. The results give new insight into this benchmark reaction. Supported by DOE.

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**SMA17 - Detection of Bilirubin Using Raman Spectroscopy in a Neonatal Skull**, *Bob Guenther, Roarke Horstmeyer, Hyun-Joong Kim; Duke University, Durham, NC 27708.* We studied the time variation of the Raman spectrum of bilirubin, a naturally occurring chemical in humans, to determine the plausibility of non-invasive detection in an infant skull. Changes of several key peaks from photoisomerization was observed, and a phantom skull was constructed from MRI images to support further research.

**SMA18 - Development and Characterization of a Cold Metastable Helium Beam.** *Bryan Conway, D. E. Chieda, E. E. Eyler, Department of Physics, University of Connecticut, Storrs, CT 06269.* We have produced a cold atomic beam of metastable  $2^3S$  helium atoms using a liquid nitrogen cooled DC glow discharge. The beam is slowed by the bichromatic force to load a magneto-optical trap. The poster addresses construction of the source and our scheme for measuring the beam's velocity distribution. Supported by NSF-REU.

**SMA19 - Constant Bias Quantum Interference Control**, *Robert L. Snider, Jared Wahlstrand, Steven Cundiff, JILA, University of Colorado and National Institute of Standards & Technology, Boulder, CO 80309.* Our project involved measuring a Quantum Interference Signal produced by the interference of one and two photon absorption on a GaAs sample. We studied both narrow ( $\sim 10$   $\mu\text{m}$ ) gap samples as well as wide gap ( $\sim 150$   $\mu\text{m}$ ) samples in an attempt to discover if we were seeing population or current control.

**SMA20 - Precision Polarimetry with Real Time Mitigation of Optical Window Birefringence**, *Byung Kyu Park, Alexander O. Sushkov, and Dmitry Budker, Department of Physics, University of California, Berkeley, CA 94720-7300.* Optical window birefringence is frequently a major obstacle in many experiments measuring changes in the polarization state of light traversing a sample under investigation. We explored a method to measure and compensate for the birefringence of an optical window using the reflection from the last optical surface before the sample. Supported by LANL and NSF.

**SMA21 - Electron-Impact Ionization of Magnesium**, *Dan Weflen, Xiaoxu Guan, and Klaus Bartschat, Department of Physics and Astronomy, Drake University, Des Moines, IA 50311.* Combining a second-order distorted-wave method for a fast ionizing projectile with a close-coupling approach for the ejected electron, we calculate electron impact ionization of magnesium. We compare with recent experimental data and other predictions, and we analyze the sensitivity of the theoretical results. Supported by NSF.

**SMA22 - Using a Feshbach Resonance to Study Ultracold Atoms in a 2D Optical Trap**, *Azure Hansen<sup>1</sup>, Pierre Cladé<sup>2</sup>, Kristian Helmerson<sup>2</sup>, William D. Phillips<sup>2</sup>, 1) Stony Brook University, Stony Brook, NY 11794, 2) NIST, Gaithersburg, MD 20899.* Ultracold atoms in quasi-2D are characterized by the coupling constant, dependent on the scattering length and confinement. A Feshbach resonance permits the scattering length to be tuned with an external magnetic field. We use this to study ultracold quantum interactions in 2D, including the Berezinskii-Kosterlitz-Thouless phase. Supported by NSF.

**SMA23 - Development of a Non-magnetic Resistive Heater for an Atomic Gyroscope**, *Lucas Willis<sup>1</sup>, Elizabeth Donley<sup>2</sup>, 1) Rowan University, Glassboro, NJ 08028, 2) National Institute of Standards and Technology, Boulder, CO, 80309.* We have constructed a non-magnetic resistive heater for table-top NMR gyroscope experiments as an alternative to forced-air heating. Atoms interact with DC and resonant AC magnetic fields. These interactions affect the gyroscope signals and put constraints on the heater design. Design considerations and stability measurements will be presented.

**SMA24 - Vortex Lattices in Optically Trapped Bose-Einstein Condensates**, *Elizabeth S. Petrik, Daniel H. Guest, Michael L. Goldman, Kevin M. Mertes, David S. Hall, Physics Dept., Amherst College, Amherst, MA 01002.* We report production of vortex lattices in  $^{87}\text{Rb}$  Bose-Einstein condensates trapped in a crossed-beam optical dipole trap. Atomic confinement in the purely optical trap is independent of spin state and magnetic bias field, permitting experiments that explore the nature of rotating spinor condensates and rotating condensates near Feshbach resonances.

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**Group Photo Break 1:55 - 2:00 PM - - - PLEASE assemble at the designated place !!!**

**Session SMD: 2:00 - 3:45 PM, Glen Ellen Room, David Sukow, Presider**

**SMD1 - 2:00 Polarization Dynamics of a Vertical-Cavity Surface-Emitting Laser (VCSEL) Under Optical Feedback**, Zachary Lapin, Binit Malla, Hong Lin, Bates College, Lewiston, ME 04240. We studied the polarization dynamics of a VCSEL at varying strengths of optical feedback in two- and three-mode regimes. Anti-phase dynamics were always observed. Under low feedback levels, the dominant polarization manifests power dropouts with a time scale much longer than the round-trip time in the external cavity. Supported by NSF.

**SMD2 - 2:15 Tellurite Based Glasses for Infrared Fiber**, A. Haldeman<sup>1</sup>, J. Massera<sup>1</sup>, R. Thieulin<sup>1,2</sup>, L. Petit<sup>1</sup>, K. Richardson<sup>1</sup>, 1) School of Materials Science and Engineering, Clemson University, Clemson, SC 29634, 2) Polytech Montpellier, University Montpellier 2, Montpellier 34090, FRANCE. This study has focused on the fabrication and characterization of tellurite-based core and core-clad preforms with good optical quality and homogenous composition for mid and near-IR (NIR) applications. To limit optical loss in the NIR, efforts to control OH content have been made. Supported by the NSF International REU program.

**SMD3 - 2:30 Thermal Profiling of VCSEL Arrays**, Kathryn J. Greenberg, M. Farzaneh, Reja Amatya, Dietrich Luerßen, and Janice A. Hudgings, Mount Holyoke College, South Hadley, MA 01075. High resolution thermoreflectance microscopy, in combination with standard wavelength shift measurements, is used to thermally profile vertical cavity surface emitting lasers (VCSELs). Relative thermal resistance and thermal lensing is reported for various VCSEL designs. In addition, significant thermal coupling is observed between VCSELs in a 1D array. Supported by the National Science Foundation, under Grant Nos. ECS-0134228, DMI-0531171, and by the Research Corporation.

**SMD4 - 2:45 Towards a Chip-Scale Atomic Gyroscope**, N. M. VanMeter<sup>1</sup>, E. Hodby<sup>2</sup>, J. Kitching<sup>2</sup>, 1) Louisiana State University, Baton Rouge, LA 70803, 2) National Institute of Standards and Technology, Boulder, CO 80309. Physical rotations cause a shift in the Larmor precession frequency of atoms. Using nuclear magnetic resonance in noble gas atoms, one can measure these shifts and hence build a rotation-sensing device, or gyroscope. Using the same technology that miniaturized atomic clocks, one can then hope to build a chip-scale gyroscope. Supported by NSF and DARPA.

**SMD5 - 3:00 Testing Hidden-Variable Theorems with Single Photons**, Bryce R. Gadway, Enrique Galvez, Colgate University, Hamilton, NY 13346. The results of an experimental test addressing the Bell-Kochen-Specker Theorem (using the Clauser-Horne-Shimony-Holt formulation) performed on an ensemble of single photons entangled in spin (polarization) and momentum (directionality) are presented. Also, plans for a single-photon GHZ-like (Greenberger-Horne-Zeilinger) experiment allowing for a Hidden-Variable test without statistics are presented. Supported by NSF.

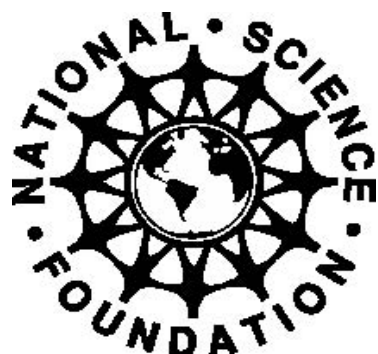
**SMD6 - 3:15 Laser Spectroscopy of Collision Dynamics in High Energy Molecules**, Felix Lin, Liwei Yuan, Juan Du, and Amy Mullin, University of Maryland, College Park, MD 20742. High-resolution transient IR laser spectroscopy at  $\lambda \sim 5 \mu\text{m}$  is used to measure energy partitioning of scattered DCI( $v=0$ ) following single collisions with highly vibrationally excited pyrazine. The nascent energy distributions of DCI from weak and strong collisions characterize the full energy transfer distribution function for vibration-to-rotation/translation energy transfer.

**SMD7 - 3:30 Spin Orbit Coupling in Quantum Information**, Y. Schultz, C. Leary, M. Raymer, Oregon Center for Optics, University of Oregon, Eugene OR 97403. Traditional methods of quantum information have focused on the polarization of photons. We are looking at encoding information by controlling the rotation of LG01 mode light within fiber by various means.



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