SYMPOSIUM ON UNDERGRADUATE RESEARCH

Division of Laser Science of A.P.S - LS XXV - 12 October 2009 - San Jose, CA

PARTICIPANTS' LUNCHEON - Cupertino Room - 12:00

The participants' lunch will bring together the Symposium students and Plenary Speaker

Dr. Janos Kirz, Lawrence Berkeley Laboratory

Lunches will be provided for participants and invited guests only.

POSTER SESSION - Cupertino Room - 12:30

Session LSMA: 12:15 - 2:25 PM, - Nicholas Bigelow, University of Rochester, Presider

LSMA1 - **Fabrication of SU-8 Microspools using Multiphoton Absorption Polymerization**, *Pearl Horng, Linjie Li, George Kumi, Erez Gershgoren, John Fourkas, University of Maryland, College Park, MD 20742*. Recent developments in microscopic patterning have made it possible to build microdevices that can be integrated into chemical and biological systems. We have used multiphoton absorption polymerization to fabricate SU-8 microspools that have been shown to rotate in solution. Supported by NSF and the Arnold & Mabel Beckman Foundation.

LSMA2 - **Optical Pumping for Vibrational Cooling of NaCs Molecules**, *Jennifer L. Hansen[1], Patrick Zabawa[2], Amy Wakim[2], Nicholas P. Bigelow[2], 1) Grove City College, Grove City, PA 16127, 2) University of Rochester, Rochester, NY 14627.* A frequency filter for a broadband laser source has been developed for use in vibrational cooling of NaCs molecules. It removes frequencies that excite molecules out of the ground vibrational state, cooling the sample by optical pumping, so that a high percentage of molecules accumulate in the ground vibrational state. This project was supported in part by NSF award PHY-0851243.

LSMA3 - **Feedback-Induced Dynamics of a Vertical-cavity Surface-emitting Laser Operating in the Multi-transverse-mode Regime,** *Erik Born, Nola Palombo, Hong Lin, Department of Physics and Astronomy, Bates College, Lewiston, ME 04240.* We have studied dynamics of a vertical-cavity surface-emitting laser with isotropic optical feedback near the threshold of higher-order transverse modes. Low frequency peaks occur in the power spectra of individual modes. The frequency and amplitude of these peaks depend upon the injection current and strength of the optical feedback. Supported by Bates College and The Howard Hughes Medical Institute.

LSMA4 - **Vibrational Sum Frequency Generation Spectroscopy Study of Acetonitrile,** *Katherine Manfred, Terry Ding, Xiaoxiao He, John Fourkas, University of Maryland, College Park, MD 20742.* Investigations into molecular organization of acetonitrile at silica-vapor, silica-liquid, and liquid-vapor interfaces have been conducted using a counter-propagating, broadband vibrational sum-frequency generation spectrometer. Results from acetonitrile, propionitrile, and trimethylacetonitrile are presented which demonstrate interesting surface layering behavior. Supported by NSF.

LSMA5 - **One-Dimensional Parity Optical Mode Sorter,** *Zachary Bond[1], Cody Leary[2], Michael Raymer[2],1) Southeastern Louisiana University, Hammond, LA 70402, 2) University of Oregon, Eugene, OR 97403.* A modified version of the Mach-Zehnder interferometer is used to sort laser modes based on 1D parity as well as to create Laguerre-Gauss modes. Details of the different modes, polarizations, and relative phase differences in the experiment will be shown and discussed.

LSMA6 - **Numerical Simulation of Spin Transitions,** *Jean McIntyre, Lilian Childress, Bates College, Lewiston, ME 04240.* The quantum dynamics of driven finite-dimensional quantum systems can be exactly solved only under single-frequency, weak excitation. To understand systems driven by strong multi-frequency fields we create programs using a Runge-Kutta approximation or a Floquet theory approach to model the solution for a 2-level system. Supported by Hughes/INBRE Student-Faculty Research Grants.

POSTER SESSION - Cupertino Room - 12:30

Session LSMA: 12:30 - 2:25 PM, - Nicholas Bigelow, University of Rochester, Presider

LSMA7 - **Semi-Empirically Determining the Population Equation of a Magneto-Optical Trap,** *Eric Bahr, Elizabeth Donley, Tara Cubel-Liebisch, John Kitching, Time and Frequency Division, NIST, Boulder CO 80305.* We present the theory behind the Magneto-Optical Trap and present measurements of the fluorescence of a rubidium trap for several parameters, most notably laser detuning. With this data, we derive a scattering equation to find the true population of the trap.

LSMA8 - **Using A Diode Laser To Probe Collisional Energy Transfer,** *Matthew Smarte, Nicholas Sassin, Geraldine Echebiri, Amy Mullin, Department of Chemistry and Biochemistry, University of Maryland, College Park, MD 20742.* A Nd:YAG laser, generating pulsed light of λ=266nm, is used to vibrationally excite pyrazine molecules. Pyrazine acts as an energy donor and collides with HCl, causing changes in rotational, translational, and vibrational energy. Transient IR absorption spectroscopy is utilized to give state-resolved energy transfer profiles of the collision dynamics. Supported by the Beckman Foundation and the Department of Energy.

LSMA9 - **Measurement of the Fine Structure Splittings in n^2F States of ^{87}Rb,** *Gennady Malyshev, John Brandenberger, Lawrence University, Appleton WI 54911.* Measurements of the fine structure splittings in n^2F states of ^{87}Rb by way of three-step laser excitation have been expanded to include n = 12 through 15. The trend in these splittings as a function of n departs from the hydrogenic case and presents a new avenue of theoretic analysis. Supported by E. Bliss, D. Skran and NSF CCLI.

LSMA10 - **Generation of Stable Droplets for Laser Induced Plasmas,** *Nathan Bodnar, John Szilagyi, Omar Rodriguez, Reuvani Kamtaprasad, Martin Richardson, University of Central Florida, Orlando, FL 32816.* Characterizing droplet formation allows the ability to construct stable debris-free plasma sources for EUV generation. The experiment showed that there is a correlation between pressure and velocity for droplet formation. When heavy metals are introduced into the system, this data will help estimate the concentration of these heavy metals. Supported by NSF -IREU.

LSMA11 - **Preparation and Manipulation of Single Nuclear Spins in the Diamond NV Center,** *Ben Smeltzer, Jean McIntyre, Lily Childress, Bates College, Lewiston, ME 04240.* We use a confocal setup to isolate single NV centers in diamond. In particular, we demonstrate the ability to polarize and manipulate the ^{14}N nuclear spin in the excited state at high magnetic fields, and subsequently drive nuclear spin transitions that can be easily read-out. Supported by Research Corp. and HHMI.

LSMA12 - **Transverse and Polarization Properties of Airy beams,** *Marshall Scott, Hsiao-harng Shiau, Reeta Vyas, University of Arkansas, Fayetteville, AR 72701.* We study Airy beam solutions to the paraxial wave equation and discuss how transverse profile and polarization properties change as the beam propagates. We compare these results with Hermite-Gaussian and Laguerre-Gaussian beams. Supported by NSF-REU.

LSMA13 - **Adaptive-Optic Aberration Measurement and Correction,** *Matthew Reichert[1], Stephan Nolte[2], Jens Thomas[2], 1) Rose-Hulman Institute of Technology, Terre Haute, IN 47803, 2) Friedrich Schiller University of Jena, Jena, Germany.* An OKO Technologies Shack-Hartmann wavefront sensor and deformable mirror measured and corrected aberrations in glass slides and microscope objectives focusing onto a plane mirror and through a cover glass. The relation between the defocus Zernike polynomial and the wavefront's radius of curvature was experimentally verified. Supported by NSF contract #ENG-0649230.

LSMA14 - **Development of a Multiplex-CARS Flow Cytometer for Label-free Real-time Particle Classification**, *Hamsa Sridhar[1], Charles Camp[2], Siva Yegnanarayanan[2], Ali Adibi[2], 1) Harvard University, Cambridge, MA 02138, 2) School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA 30332.* We describe the development of a Multiplex Coherent Anti-Stokes Raman Spectroscopy (MCARS) system based on broadband light created by a femtosecond laser. Microfluidic channels for flow cytometry were designed and fabricated and a MATLAB program was written to analyze the MCARS spectra. Supported by NSF-REU.

LSMA15 - **Visualizing the Gouy Phase,** *Thomas Videbaek, Martin Cohen, and John Noé, Laser Teaching Center, Stony Brook University, Stony Brook, NY 11794.* We have investigated and further simplified the "ghost-beam" interferometric method proposed by J. Peatross and M. Pack [AJP, 2001] for visualizing changes in the Gouy phase near the focus of a laser beam. Supported by NSF-REU.

POSTER SESSION - Cupertino Room - 12:30

Session LSMA: 12:30 - 2:25 PM, - Nicholas Bigelow, University of Rochester, Presider

LSMA16 - **Investigation of Diode Laser Light Coupling into a Power Build-up Cavity for Frequency Doubling,** *Lindsey Andrews, Charles Sukenik, Old Dominion University, Norfolk, VA 23529.* We have investigated the coupling of diode laser light into a commercial power build-up cavity. We will report on our study of the coupling efficiency of light into the cavity as a function of the spatial parameters of the laser. Supported by the ODU Honors College.

LSMA17 - **Miniaturizing Magnetometers: A MEMS Approach**, *Katrina Bossert[1], Jan Preusser[2], Svenja Knappe[2], John Kitching[2], 1) University of Colorado Boulder, Boulder, CO 80309, 2) Time and Frequency Division, NIST, Boulder, CO 80305.* We have created a miniaturized all-optical Rb-cell magnetometer by MEMS fabrication techniques. It operates in the spin-exchange relaxation-free (SERF) regime and uses a pump-probe setup. Light is fed to the magnetometer through optical fibers and the magnetic field is sensed by the polarization rotation of the probe beam. Supported by NIST Summer Undergraduate Research Fellowship (SURF).

LSMA18 - **Study of Diffraction Patterns using Fourier-transform Techniques**, *Rahul Khakurel[1], Margo Kinneberg[1], Alicia M. Sampson[2], 1) Vassar College, Poughkeepsie, NY 12604, 2) Dutchess Community College, Poughkeepsie, NY 12601.* We explored the theory of diffraction patterns using Fourier transforms and the related functionalities of Matlab. Our objective is to eventually monitor the movement and growth of microorganisms by studying their diffraction patterns. Supported by URSI.

LSMA19 - **Understanding Image Formation in the Wave Theory of Light,** *Max Tolkoff[1], Martin Cohen[2], John Noé[2], 1) Tufts University, Medford, MA 02155, 2) Stony Brook University, Stony Brook, NY 11794.* When the diffraction pattern from two or more slits traverses a convex lens, it evolves into a pattern that resembles the original slits, but in which the slit widths may appear narrower relative to their separation than expected. We modeled this imaging process in Mathematica, treating the lens as a radius-dependent phase element. Supported by NSF-REU.

LSMA20 - **Alignment of a CR-699 Ring Dye Laser**. *Roshita Ramkhalawon, Amy Wakim, Patrick Zabawa, Nicholas Bigelow*, *University of Rochester, Rochester, NY 14627*. We describe the operation and alignment of a 600 - 700 nm CR-699 ring dye laser pumped by an 8.0 W Argon-ion laser. The ring laser will be used to perform depletion spectroscopy on ultracold NaCs molecules. Supported by NSF.

LSMA21 - **Simple Model and Characterization of a Fiber-coupled Diode Laser,** *Colby Reneau, Ali Khademian, and David Shiner, University of North Texas, Denton, TX 76203.* Simple measurements were taken to characterize and model a fiber-coupled diode laser. The methods will be discussed, as well as the determined laser parameters, such as the laser gain and parasite absorption, the front and back facet reflectivity and the laser-to-fiber coupling efficiencies.

LSMA22 - **Energy Transfer of CdSe Quantum Dots using Two-Wave Mixing,** *Jasmine Austin, Jelyn Moore, Quiguang Yang, Bagher Tabibi, Hampton University, Hampton, VA 23668.* The energy transfer between the pump and probe beams through CdSe quantum dots was examined by two-wave mixing. A phase shift between the two input beams occurred due to the nonlinear optical properties of the CdSe quantum dot and led to energy transfer between the two beams. Supported by NSF.

LSMA23 - **Laser Gain Media Utilizing Composite Materials.** *Daniel Lum[1], Robert Boyd[2], Andreas Liapis[2], 1) Louisiana State University, Baton Rouge, LA 70803, 2) University of Rochester, Rochester, NY 14627.* Characteristics of laser gain media scale with the net refractive index of the material. We attempt to test this hypothesis by measuring the upper state lifetime and the small signal gain of rhodamine 6G / polymethyl methacrylate / silica nanoparticle composites. Supported by NSF.

LSMA24 - **Using Atomic Magnetometers to Detect Biomagnetism in *Amorphophallus Titanum*,** *N. Baddour, B. Patton, E. Corsini, B. Lester, D. Budker, University of California Berkeley, Lawrence Berkeley Laboratory, Berkeley, CA 94720.* We discuss the use of optical magnetometers to measure the magnetic field created during the high metabolism blooming of the "giant corpse flower" at the University of California Botanical Garden. Supported by ONR.

SYMPOSIUM ON UNDERGRADUATE RESEARCH

Division of Laser Science of A.P.S - LS XXV - 12 October 2009 - San Jose, CA

Group Photo Break 2:25 - 2:30 PM - - - PLEASE assemble at the designated place !!!

Session LSME: 2:30 - 4:00 PM, Fairfield Room - John Fourkas, Univ. Maryland, Presider

LSME1 - **Homodyne Detection in a Laser Locking System**, *Aaron W. Bennett, Christopher J. Erickson, Dallin S. Durfee, Brigham Young University, Provo, UT 84602*. We will discuss a high-speed, low-noise homodyne photo-detector used to implement the Pound Drever Hall technique. We will discuss aspects of the detector which allow it to operate with lower noise and over a higher bandwidth than other detectors we have investigated. Supported by a NIST precision measurement grant and BYU's College of Physical and Mathematical Sciences.

LSME2 - **A Slow-Ion Source for a Strontium Ion Matter-wave Interferometer,** *Kelvin J. Blaser, Christopher J. Erickson, Dallin S. Durfee, Brigham Young University, Provo, UT 84602.* We report on the development of a source of slow strontium ions for a matter-wave interferometer. The source is an LVIS using a magneto-optical-trap operating on the $5s^2$-$^1S_0$ to 5s5p-$^1P_1$ transition of strontium, which generates a slow atomic beam to be ionized. Supported by NSF-REU and a NIST Precision Measurement Grant.

LSME3 - **A Laser Lock System using Multiple Overlapping Beams**, *Stuart Harper, Christopher Erickson, Dallin S. Durfee, Brigham Young University, Provo, UT 84602.* We describe a system wherein the lock of trapping, ionizing, and ion resonance lasers for a Sr experiment are bootstrapped together in a single vapor cell. This is done by overlapping beams to optically pump the atoms. Supported by NIST and BYU's College of Physical & Mathematical Sciences.

LSME4 - **Tunable Pulse Advancement/Delay via SBS,** *Peter Wills[1], Zhimin Shi[2], Aaron Schweinsberg[2], Robert Boyd[2], 1) Reed College, Portland, OR 97202, 2) University of Rochester, Rochester, NY 14627.* In an SBS system, we achieve tunable pulse advancement and delay via intensity modulating the pump field with variable modulation frequency. We observe a fractional advancement of 0.31 and a fractional delay of 0.83, relative to the full-width half maximum of the 4 ns Gaussian pulse. This project was supported in part by NSF award PHY-0851243.

LSME5 - **Ionization of Hydrogen and Lithium Atoms in Short-Pulse Intense Laser Fields,** *Brant Abeln[1], Daniel Weflen[1], Klaus Bartschat[1], Alexei Grum-Grzhimailo[2], 1) Drake University, Des Moines, IA 50311, 2) Moscow State University, Moscow 119991, Russia.* The yield and the angular distribution of ejected electrons in strong-field ionization can be strongly dependent on the intensity, length, and carrier envelope of the incident laser radiation. These effects are being investigated by solving the time-dependent Schrödinger equation directly on a numerical space-time grid. Supported by the NSF under PHY-0757755.

SYMPOSIUM ON UNDERGRADUATE RESEARCH

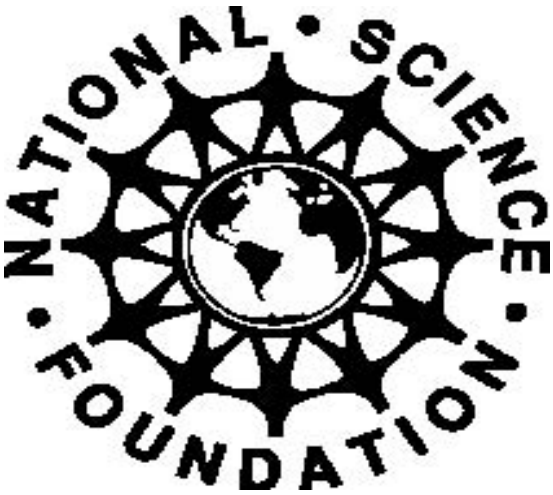
Division of Laser Science of A.P.S - LS XXV - 12 October 2009 - San Jose, CA

Session LSMI: 4:15 – 5:00 PM, Fairfield Room - Leo Hollberg, AOSense, Inc., Presider

LSMI1 - **Electric Field Assisted Chemical Restructuring on Glass Surfaces,** *C. Smith[1], T. Cardinal[2], M. Dussauze[3], V. Rodriguez[3], E. Fargin[2], K. Richardson[1], L. Petit[1], 1) School of Materials Science and Engineering, COMSET, Clemson University, SC 29634, 2) Institut de Chimie de la Matière Condensée de Bordeaux, 33608 Pessac Cedex, France, 3) Institut des Sciences Moléculaires, Groupe de Spectroscopie Moléculaire, Université Bordeaux I, 33405 Talence Cedex, France.* This work examines the changes induced by the application of an electric field during heating to soda lime glasses. The properties of the glasses that developed because of the poling were determined through use of second harmonic generation (SHG) measurement, micro-Raman and infrared (IR) spectroscopies. Work supported by NSF-IREU.

LSMI2 - **Development of a Compact All-Optical Atomic Magnetometer,** *Brian Lester[1], Brian Patton[2], D. Chris Hovde[3], Dmitry Budker[2,4], 1) California Institute of Technology, Pasadena, CA 91125, 2) Department of Physics, University of California, Berkeley, CA 94720, 3) Southwest Sciences Inc., Cincinnati, OH 45244, 4) Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720.* The development of a compact all-optical atomic magnetometer, based on amplitude modulated nonlinear magneto-optical rotation (AM NMOR), is described. The magnetometer is designed to make high-precision, localized measurements with tight size restrictions, specifically those required for measuring the magnetic field within the neutron electric dipole moment experiment (nEDM). Supported by Caltech SURF and Southwest Sciences Inc.

LSMI3 - **Design and Implementation of a Timing Control System for Use in a Bose-Einstein-Condensate (BEC) Experiment,** *Daniel N. Gresh, Nicholas P. Bigelow, University of Rochester, Rochester, NY 14627.* A high-precision timing system is required not only to create a BEC, but also to perform experiments on it and control steady-state operations in the lab. I designed and implemented the major hardware and logical pieces with microsecond precision on up to 100 digital and analog channels. Supported by NSF and ARO.



Symposium organized by Harold Metcalf and John Noé, Stony Brook University