SYMPOSIUM ON UNDERGRADUATE RESEARCH

Division of Laser Science of A.P.S. - LS XXI - 17 October 2005 - Tucson, AZ

12:00 noon – LUNCH - and Poster Session

We will serve lunch to all participants just outside Canyon Suite II

Session LMA: 12:00 PM – 1:30 PM, Canyon Suite I/II Balcony - John Noé, Stony Brook University, Presider

LMA1 **- Dielectric Properties and Magnetic Impurities in Pb(Zr,Ti)O_3 (Lead Zirconate Titanate),** *Benjamin Zaks, Alexander Sushkov, and Dmitry Budker; University of California, Berkeley, USA.* Ferroelectric materials such as Pb(Zr,Ti)O_3 have been proposed for experiments that will search for a Schiff moment of the Pb-207 nucleus. As a preliminary step, we are using sensitive magnetometers to measure the change in magnetization after repoling to look for any ferromagnetic impurities in the sample. Supported by URAP and NSF.

LMA2 - **Spectroscopic Tests of Bose-Einstein Statistic for Photons.**, *Yaniv Rosen, Damon English, Valeriy Yashchuk, Dmitry Budker; UC-Berkeley, USA.* The experiment limits the exchange-antisymmetric component of photon ensembles by driving degenerate J=0 to J'=1 two-photon transitions in barium, which are strictly forbidden by the spin-statistics theorem. The same apparatus allows high-resolution spectroscopy of hyperfine structure of difficult-to-access states. Supported by NSF.

LMA3 **- Conversion Efficiency of Laser-Generated High-Order Harmonics in Extended Gas Cells,** *Mark Adams, Nichole Farnsworth, Gavin Giraud, John Painter, Nathan Powers, and Justin Peatross; Brigham Young University, Provo, UT, USA.* We report on absolute energy measurements of high-order harmonics generated in a gas cell that fills the region from the focusing optics to an exit foil near the laser focus. Supported by NSF through REU.

LMA4 **- Optical Studies of Adsorption on Functionalized Colloidal Polystyrene Spheres**, *Allison K. Pymer[1], Fuyuo Nagayama[2], R. Kramer Campen[3], Eric Borguet[1]; [1]Temple University, USA, [2]Central High School, Philadelphia, PA, USA, [3]Pennsylvania State University, USA.* Understanding adsorption on complex particulate materials is important for applications ranging from geochemistry to paint formulation, but difficult to probe in-situ. Second harmonic generation (SHG) and conventional optical techniques reveal that molecular adsorption on chemically functionalized micron-sized particles leads to adsorption isotherms characteristic of multi-site adsorption. Supported by Temple Univ. Diamond Scholars Program.

LMA5 **- The *x*-component of a *y*-polarized Hermite-Gauss Laser Beam.** *Jared W. Moore, John Vickers, Reeta Vyas, Surendra Singh; University of Arkansas, Fayetteville, USA.* Maxwell's equations require that a linearly polarized laser beam, such as a Hermite-Gauss beam, must possess a small cross-polarization component. We use a linearly polarized light beam from an Ar-ion laser operating in the fundamental Hermite-Gauss mode and present experimental evidence for the cross-polarization component of a linearly polarized laser beam. Supported by NASA.

LMA6 - **An External Cavity Diode Laser with an Intracavity Faraday Isolator**. *Rebecca Tang, Brian Neyenhuis, Scott Bergeson and Dallin S. Durfee*; *Physics Department, Brigham Young University, Provo, UT, USA*. We will discuss an external cavity diode laser with an intracavity isolator. This design combines the Littrow scheme's higher output power with the Littman-Metcalf scheme's stable beam pointing. A zeroth-order model predicts almost no mode-hop-free scan range, but in practice we have achieved as much as 45 GHz. Supported by Research Corporation.

LMA7 - **Progress Towards a Hz Stable 657 nm Diode Laser**. *Brian Neyenhuis, Rebecca Tang, Scott Bergeson, and Dallin S. Durfee*; *Physics Department, Brigham Young University, Provo, UT, USA*. We describe a 657 nm laser for use in a Ca interferometer. This laser is locked to a high finesse optical cavity using high speed electronics to expand the servo bandwidth. The goal of Hz level stability and progress towards it will be discussed. Supported by NSF-REU and Research Corp.

LMA8 **-** see abstract for oral contribution LMF1.

<u>SYMPOSIUM ON UNDERGRADUATE RESEARCH</u>

Division of Laser Science of A.P.S. - LS XXI - 17 October 2005 - Tucson, AZ

<u>Session LMC</u>: 1:30 PM – 3:15 PM, Canyon Suite II - Justin Peatross, Brigham Young University, Presider

LMC1 1:30 PM **- Stimulated Raman Scattering in an Ethanol Core Microstructured Optical Fiber,** *Peter Iapozzuto[1], S. Yiou[2], P. Delaye[2], A. Rouvie[2], J. Chinaud[2], R. Frey[2], and G. Roosen[2]; [1]Stony Brook University, USA, [2]Laboratoire Charles Fabry, Institut d'Optique, Orsay, France.* High efficiency stimulated Raman scattering using a hollow core photonic crystal fiber filled with a low refractive index non-linear liquid was studied. The chosen liquids were ethanol and acetone. Supported by the NSF International REU program, #0244109.

LMC2 1:45 PM **- Hyperfine Splittings in ^{83}Kr,** *Rupesh Silwal and John R. Brandenberger; Lawrence University, Appleton, WI, USA.* Hyperfine splittings in the $4d_4$ and $4d_5$ states of ^{83}Kr (I = 9/2) have been measured using two-step laser excitation, an rf discharge and external-cavity diode lasers. These are the first measurements of these particular hyperfine splittings. Supported by Research Corporation and W. M. Keck Foundation.

LMC3 2:00 PM **- Linear and Nonlinear Measurements on Exposed Silica**, *Lidiya Mishchenko[1], Lionel Canioni[2], Laurent Sarger[2], Arnaud Royon[2], Clara Rivero[3], Arnaud Zoubir[3], Martin Richardson[3], Kathleen Richardson[3]; [1]Univ. of Maryland, Baltimore, USA, [2]University Bordeaux 1, Talence, France, [3]Univ. of Central Florida, USA.* Raman spectroscopy, absorption spectroscopy, and third harmonic generation measurements were performed on exposed silica to study changes in their linear and nonlinear properties. These data were used to analyze structural defects within the silica and to measure the associated changes of their optical properties. Supported by the NSF International REU program, #0244109.

LMC4 2:15 PM **- Testing the Limits of Precision Radio Frequency Measurements for Optical Frequency Metrology**, *Melissa E. Friedman[1], M. Zimmermann[2], R. Holzwarth[2], T.W. Hänsch[2]; [1]Stony Brook University, USA, [2]Max Planck Institute for Quantum Optics, Garching, Germany.* The frequency-comb technique uses a mode-locked laser to accurately measure optical frequencies. To maximize precision we must investigate and eliminate sources of noise. We explore the effects of temperature, supply voltage, and power levels on the detection of the pulse repetition rate of a femtosecond fiber laser. Supported by the NSF International REU program, #0244109.

LMC5 2:30 PM **- Stark Effect Using Rydberg Helium Atoms and the STIRAP Technique,** *Kyung Soo Choi[1], Jonathan Kaufman[2], Sung Hyun Lee[1], Harold Metcalf[1]; [1]Stony Brook University, USA, [2]University of Pittsburgh, USA.* The large dipole moments in Rydberg atoms make possible atom-optical elements in inhomogeneous E-fields. Stark spectroscopy can determine the sign of the dipole moment and we present our results for n=26. Highly efficient population of the Rydberg states in a two-step process is enhanced by Stimulated Raman Adiabatic Passage (STIRAP). Supported by ONR and NSF.

LMC6 2:45 PM **- Ultracold Physics Studies with a Rb-Ar* Dual Species Magneto-Optical Trap,** *Robert A. Horne, Michael K. Shaffer, Eman M. Ahmed, Huake C. Busch, and Charles I. Sukenik; Old Dominion University, Norfolk, VA, USA.* We will report our findings on the search for ultracold molecule production in a dual species magneto-optical trap comprised of rubidium and metastable argon atoms. We will also discuss ongoing upgrades to the apparatus which will increase the sensitivity of cold collision studies. Supported by NSF through REU.

LMC7 3:00 PM **- Adaptive Control of the Spatial Position of White Light Filaments in an Aqueous Solution,** *George Heck, Joseph Sloss, Robert J. Levis; Temple University, Philadelphia, PA, USA.* We demonstrate control over the spatial coordinates of white light filaments using a 50 fs, 800 nm excitation laser pulse. The setup employs a closed feedback loop with a spatial light modulator and a genetic algorithm to manipulate the spectral phases of the pulses to achieve a specified filament position and length. Supported by NSF and DoD MURI program.

SYMPOSIUM ON UNDERGRADUATE RESEARCH

Division of Laser Science of A.P.S. - LS XXI - 17 October 2005 - Tucson, AZ

Session LME: **3:30 – 5:15 PM, Canyon Suite II - Martin Richardson, University of Central Florida, Presider**

LME1 3:30 PM **- Characterization and Analysis of Single Terrylene Molecules in a p-Terphenyl Crystal**, *Christopher A. Werley and W. E. Moerner; Stanford University, USA.* Single terrylene molecules within a spin-cast, p-terphenyl crystal were visualized with fluorescence microscopy. Observed molecules either had fixed position and dipole alignment or dynamically moved microns within the confines of a crystal defect. Molecular orientation, lifetimes, and constrained diffusion will be discussed. Supported by NSF.

LME2 3:45 PM **- First Step in the Enhancement of the Luminescence of Dy^{3+} and Eu^{3+} Doped Silica Nanoparticles,** *Jessica Griffin[1], V. Jubera[2], N. Carlie[1], L. Petit[1], M. Garcia[1], F. Hernandez[1], and K. Richardson[1,3]; [1]University of Central Florida, USA, [2]Institut de Chimie de la Matière Condensée de Bordeaux, Université Bordeaux-1, France, [3]Clemson University, USA.* Silica nanoparticles, prepared by the Stober method, have been doped with Dy^{3+}, Eu^{3+}, and/or Au. The effect of the rare earth content on the emission has been studied as well as the effect of the Au addition on the luminescence of Eu^{3+} doped SiO_2 nanoparticles. Supported by the NSF International REU program, #0244109.

LME3 4:00 PM **- Characterization of Optical Waveguides in Luminescent Material Samples,** *Joanna Lankester[1], Julien Cabaret[2], Paul Moretti[2], Marta Szachowicz[2]; [1]Washington University, USA, [2]Laboratoire de Physico-Chimie des Matériaux Luminescents, Université Claude Bernard Lyon I, Lyon, France.* This study examines the effects of ion implantation parameters on the properties of waveguides in luminescent materials. Laser beam light is injected into a sample via an optical fiber, and a camera captures an image of the light upon exit with the aid of an objective. Supported by the NSF International REU program, #0244109.

LME4 4:15 PM **- Laser Levitation of Microscopic Particles in an Ambient Gas,** *Rhett Lindsey, Adam Hendrickson, John Painter, Rob Petersen, Chris Young, and Justin Peatross; Brigham Young University, Provo, UT, USA.* We observe radiometric levitation of non-transparent particles such as tungsten. Particles become trapped near the focus of the laser beam in air. We document the motion and size of trapped particles as the surrounding gas pressure is varied from about a few Torr to several atmospheres. Supported by BYU.

LME5 4:30 PM **- High-Order Harmonic Generation in Extended Gas Cells,** *Gavin Giraud, Nichole Farnsworth, John Painter, Nathan Powers, Julia Sutherland, and Justin Peatross; Brigham Young University, Provo, UT, USA*. We describe laser-generated high-order harmonics produced in extended gas cells. Phase matching is influenced by an interaction between the laser and the gas. The harmonic brightness markedly increases when an aperture is partially closed on the laser beam. Supported by NSF through REU.

LME6 4:45 PM **- Using High-Order Harmonic Generation for Extreme Ultraviolet Polarimetry,** *Nathan Powers, Nichole Farnsworth, Sergei Voronov, and Justin Peatross; Brigham Young University, Provo, UT, USA.* Laser-generated high-order harmonics are ideally suited for measuring polarization-dependent reflectances of optical surfaces in the extreme ultraviolet. We are constructing a polarimeter with a wavelength range from ~10 nm to ~70 nm. The polarization orientation of the laser governs the polarization of the high harmonic light. Supported by NSF through REU.

LME7 5:00 PM **- Simulations of Laser Self-Focusing Under Conditions for High-Order Harmonic Generation,** *Matthew Turner and Justin Peatross; Brigham Young University, Provo, UT, USA.* We numerically solve the scalar wave equation with nonlinear coupling between a loosely focused ultra-short intense laser pulse and a medium such as helium at 100 Torr. Self focusing due to the optical Kerr effect and defocusing from ionized free electrons are included in the model. These influence the phase matching of generated high-order harmonics. Supported by BYU.

SYMPOSIUM ON UNDERGRADUATE RESEARCH

Division of Laser Science of A.P.S. - LS XXI - 17 October 2005 - Tucson, AZ

Session LMF: 5:30 – 7:00 PM, Canyon Suite II - Richard Haskell, Harvey Mudd College, Presider

LMF1 5:30 PM **- Narrowing Spectral Linewidth of a Multi-mode Vertical-Cavity Surface-Emitting Laser Using Optical Feedback**, *H. Min Hlaing, David Thomazy, and Hong Lin; Bates College, Lewiston, ME, USA.* We have observed experimentally that the spectral linewidth of a multi-mode VCSEL can be narrowed down significantly by adjusting the alignment of the feedback mirror. In some cases the multi-mode spectrum can be reduced to a quasi-single mode. Supported by NSF and Bates College.

LMF2 5:45 PM **- Imaging Early Frog Embryo Development with Optical Coherence Microscopy,** *Daniel Strenge, Stephanie Feldman, and Richard Haskell; Harvey Mudd College, Claremont, CA, USA.* We imaged Xenopus laevis embryos using two Optical Coherence Microscopes with 1300 nm and 850 nm broadband light sources respectively throughout gastrulation and neurulation. We present time-lapse movies of internal developmental events such as mesendodermal involution and neural fold formation real-time and in-vivo. Supported by Howard Hughes Medical Institute.

LMF3 6:00 PM **- Lissajous Polarization from Single-Beam Interference,** *Cynthia Castellon and Enrique Galvez; Colgate University, Hamilton, NY, USA.* We can observe new polarization states beyond the linear, circular, and elliptical by superimposing two light beams of commensurate frequencies. The resultant electric field vector traces out a Lissajous curve as it propagates. The required component beams are the fundamental and second harmonic of a single beam. Supported by Colgate University.

LMF4 6:15 PM **- Simplified Methods for Creating Optical Vortices,** *Amol Jain[1], Gregory Caravelli[2], John Noé[3], and Harold Metcalf[3]; [1]Herricks High School, New Hyde Park, NY, USA, [2]Johns Hopkins University, USA, [3]Stony Brook University, USA.* Optical vortices are created by manipulating the phase and/or amplitude distribution of a laser beam. We have produced useful vortices with: 1) spiral phase plates made from cracked or cut plastic sheets, and 2) computer-generated amplitude holograms printed directly on transparencies. A composite CGH will be used as a vortex mode analyzer. Supported by NSF-REU and the Simons Foundation.

LMF5 6:30 PM **- Trapping a Bose-Einstein Condensate with an Optical Vortex Beam,** *Azure Hansen[1], Kevin Wright[2], Nicholas Bigelow[2]; [1]Stony Brook University, USA, [2]University of Rochester, USA.* BEC's can be trapped and manipulated with Laguerre-Gaussian (optical vortex) laser beams. The dipole force of a blue-detuned beam confines the BEC; a red-detuned beam creates a toroidal BEC. A suitable 50 mW first-order LG beam was created with a 780 nm laser diode, tapered amplifier chip and computer-generated phase hologram. Supported by NSF-REU.

LMF6 6:45 PM **- Electro-Optic Sampling of Ultrafast Terahertz Transients,** *Molly Bright[1], Peter Gaal[2], Klaus Riemann[2]; [1]MIT, USA, [2]Max-Born-Institute für Nichtlineare Optik und Kurzzeitspektroskopie, Berlin, Germany.* Femtosecond terahertz pulses have been created via two distinct frequency mixing techniques and analyzed using ultrafast electro-optic sampling in ZnTe. Planned spectroscopy applications and initial testing will be discussed. Supported by the NSF International REU program, #0244109.