SYMPOSIUM ON UNDERGRADUATE RESEARCH

Division of Laser Science of A.P.S - LS XXII - 9 October 2006 - Rochester, NY

LUNCH AND POSTER SESSION

We will serve a complimentary lunch in the Highland B Room for all symposium participants.

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

Session LMA (poster): 12:00 - 1:55 PM, Riverside Court - Nick Bigelow, U. Rochester, Presider

LMA1 - **Off-resonant Defocus-contrast Imaging of Atomic Clouds,** *Lidiya Mishchenko[1], Nicholas Bigelow[2], Kevin C. Wright[2], and Andrew Kowalik[2]; 1) University of Maryland, Baltimore County, Baltimore, MD 21250, 2) University of Rochester, Rochester, NY 14620.* Off-resonant defocus contrast images were taken of magneto-optically trapped clouds, thermal clouds formed via evaporative cooling, and Bose Einstein condensates. The images were used to derive the optical densities of these clouds, and the results were compared to those of absorption imaging. Supported by NSF.

LMA2 - **Optical Frequency Control by Phase Modulating a Self-Injection-Locked Diode Laser,** *Charles Rogers III, Matthew Wright, Jennifer Carini, Joseph Pechkis, Phillip Gould; University of Connecticut, Storrs, CT 06269.* The variation of optical frequency within a pulse of laser light is explored using multiple passes through a fiber-based electro-optic phase modulator. The modulator is coupled to a fiber-optical delay line and self-injection-locked diode laser to extend its capability of manipulating the frequency of the diode. Supported by the U.S. Department of Energy.

LMA3 - **Spin-Orbit Coupling of the NaK $3^3\Pi$ and $3^1\Pi$ States,** *Steve Eckel[1,2], Seth Ashman[1], J. Huennekens[1]; 1) Lehigh University, Bethlehem, PA 18015, 2) Yale University, New Haven CT 06511.* We have studied the mutually perturbing $3^3\Pi_{\Omega=0}(v = 32, J = 19, e/f) \sim 3^1\Pi_{\Omega=1}(v = 6, J = 19, e/f)$ levels of NaK using double resonance spectroscopy. The *f* symmetry pair provides a direct measure of the spin-orbit coupling strength, while dramatic quantum interference effects can be observed in the spectra of the *e* symmetry pair. Supported by NSF-REU.

LMA4 - **Optical Characterizations of TeO_2 Fibers,** *J. A. Harris[1, 2], V. Dierolf[2], P. Capek[2], N. Woodward[2]; 1) Grambling State University, Grambling LA 71245, 2) Lehigh University, Bethlehem, PA 18015.* We studied novel telluride fibers doped with Er^{3+} ions for applications in compact optical fiber lasers and amplifiers. We applied Fabry-Perot interferometry to determine the propagation losses, confocal Raman spectroscopy to determine the structural changes across the fiber cross-section and Er^{3+} luminescence spectroscopy to determine and optimize the properties of the Er ions in the glass matrix. Supported by NSF-IMI, NSF-REU, NSF-Europe (DMR-0349632) and NSF-MWN (DMR-0602986).

LMA5 - **Site-Selective Spectroscopy Of Erbium Ion In Lithium Tantalate,** *K. Miyahara[1,2], P. Capek[2], Z. Fleischman[2], V. Dierolf[2]; 1) Mt. Union College, Alliance, OH 44601, 2) Lehigh University, Bethlehem, PA 18015.* We studied optical transitions of Er^{3+} in stoichiometric $LiTaO_3$ samples using combined excitation-emission spectroscopy and identified several defect sites with their energy levels. While these sites are quite similar to the ones in the widely studied $LiNbO_3$ host, their behavior under thermal annealing is quite different. Supported by NSF-REU, NSF-DMR.

LMA6 - **Control Implementation for a Stable 657 nm Laser,** *Matthew Washburn, Brian Neyenhuis, James Archibald, Dallin S. Durfee; Brigham Young University, Provo, UT 84602.* We will discuss instrumentation for a 657 nm grating-stabilized diode laser locked using the Pound-Drever-Hall method to an optical cavity with a finesse of 30,000, focusing on the implementation of detection and feedback control systems with low noise and high bandwidth. We anticipate linewidths below 100 Hz. Supported by BYU's Office of Research and Creative Activities.

LMA7 - **Effects of Noise on Optimal Atomic Clock Frequency Measurements and Precision,** *Andrew Jacobs, James Clemens; Miami University, Oxford, OH 45056.* We have investigated the performance of an atomic clock based on an N-atom Greenberger-Horne-Zeilinger (GHZ) state, incorporating the effects of environmental noise by applying the depolarizing noise model during the preparation of the GHZ state. Supported by Miami University Undergraduate Summer Scholars Program.

LMA8 - **Femtosecond Irradiation of a Phosphate Glass Containing Silver,** *Erin Riley[1], Lionel Canioni[2], Thierry Cardinal[2], Matthieu Bellec[2]; 1) University of Central Florida, Orlando, FL 32816, 2) University of Bordeaux I, Bordeaux, France.* We report on exposing a photosensitive phosphate glass containing silver to infrared femtosecond pulses. Several silver species such as Ag^0, Ag^{2+}, and Ag_3^{2+} and non-spherical silver nanoparticles inside a glass developed under a UV lamp were observed. A possible formation mechanism is also presented. Supported by NSF and CNRS.

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LMA9 - **Cesium Hyperfine State Changing Collisions**, *Tyler Drake[1], L. Morgus[1], T. Morgus[2], J. Huennekens[3]; 1) Drew University, Madison, NJ 07940, 2) East Stroudsburg University, East Stroudsburg, PA 18301, 3) Lehigh University, Bethlehem, PA 18015.* Cs ($6P_{1/2}$, F=3) + Ar ↔ Cs($6P_{1/2}$, F=4) + Ar hyperfine state changing (HFSC) collisions have been studied in a two-step excitation experiment. We report the rate coefficient for this process and the one-dimensional velocity-changing collision kernel for atoms undergoing a single HFSC collision. We also report $6P_{1/2} \rightarrow 8S_{1/2}$ pressure broadening and shift parameters for collisions with Ar perturbers. Supported by NSF-REU.

LMA10 - **Fast Photoinduced Refractive Index Modulation in Chalcogenide Glass,** *Annemarie Exarhos[1], J. C. May[2], P. La Porta[2], Himanshu Jain[2], Ivan Biaggio[2]; 1) Lawrence University, Appleton, WI 54911, 2) Lehigh University, Bethlehem, PA 18015.* The nanosecond time dynamics of the refractive index change in chalcogenide glass have been investigated using volumetric gratings. Relaxation time following pulsed excitation, intensity dependence, and the effects of polarization were studied. Supported by NSF-REU.

LMA11 - **An Optical Vortex-Based Azimuthal Lattice for Rotating a Bose-Einstein Condensate,** *Azure Hansen[1], Pierre Cladé[2], Kristian Helmerson[2]; 1) Stony Brook University, Stony Brook, NY 11794, 2) NIST, Gaithersburg, MD 20899.* An optical lattice created by the interference of two co-propagating Laguerre-Gaussian (LG) laser beams of equal and opposite helicity is used to study a BEC. The LGs' spiral phase creates a petal-like azimuthal interferogram. We can precisely control and rotate the interferogram, for example, to give angular momentum to the BEC. Supported by NSF.

LMA12 - **The Study of Tellurium-rich Bulk Glasses and Thick Films for Future Applications in Infrared Integrated Optics,** *Diane Crenshaw[1], Caroline Vigreux-Bercovici[2], Elodie Bonhomme[2]; 1) Mount Holyoke College, South Hadley, MA 01075, 2) Université Montpellier II, Montpellier, France.* Five tellurium rich chalcogenide glasses, $Ga_5Ge_{15}Te_{80}$ and $Ge_{15}As_{15}Se_{70-x}Te_x$ with x = 56, 60, 63, and 67, and two thick films, $Ga_5Ge_{15}Te_{80}$ and $Ge_{15}As_{15}Se_3Te_{67}$, were synthesized and the structural, optical, and thermal properties analysed. The syntheses, compositional analyses, and properties of the glasses and films will be addressed in the poster. Supported by NSF and Alcatel Space.

LMA13 - **Intensity Correlations of a Modulated Diode Laser at Threshold,** *B. P. Smith, M. L. Terraciano, L. A. Orozco; University of Maryland, College Park, MD 20742.* We measure intensity correlations with a standard storage oscilloscope of an infrared diode laser modulated by various waveforms near threshold. The photon correlations are directly related to the frequency and shape of the modulating waveform. Supported by NSF.

LMA14 - **Investigation of the Stark Effect in Rydberg States of H_2 and the Results of a Semi-Classical Analysis,** *Jack M. DiSciacca, Eric Sia Kuan-Rong, Jon M. Lambert, Thomas J. Morgan; Wesleyan University, Middletown, CT 06459.* Experimental results of recurrence spectroscopy of H_2 are presented. The quantum absorption spectrum of the scaled energy Stark effect is Fourier transformed providing a semi-classical orbital interpretation. The results are compared to the equivalent united atomic system, Helium. Supported by NSF.

LMA15 - **Wavelength References for Lithographic Interferometry,** *Aaron Pung[1], Richard Fox[2]; 1) Kansas State University, Manhattan, KS 66502, 2) NIST, Boulder, CO 80305.* Computer simulations and optical frequency measurements were performed in support of the NIST wavelength reference project. Numerical modeling was used to model distortion due to non-uniform thermal expansion of optical cavity spacers. The temperature dependence of the phase-shift upon reflection of thin film coatings was determined with dual Fabry-Perot cavities.

LMA16 - **Measurements of the Landé *g*-factor of the $2p_3$ state of ^{84}Kr,** *Erik Garbacik, John R. Brandenberger; Lawrence University, Appleton, WI 54911.* Utilizing saturated absorption spectroscopy we have determined the *g*-factor of the $2p_3$ state of ^{84}Kr by invoking transitions out of the $1s_3$ metastable state. Data analysis has been performed with the aid of modified Lorentzian curve-fitting and a 4-meter effective length Fabry-Perot cavity. Supported by the Keck Foundation.

LMA17 - **An Investigation of Novel MOT Magnetic Field Geometries,** *Eric Duchon[1], Frank Moscatelli[1], Jin Wei Wu[2], Eun Oh[2]; 1) Swarthmore College, Swarthmore, PA 19081, 2) Naval Research Laboratory, Washington, DC 20375.* This experiment numerically evaluates and characterizes the field of two permanent ring magnets. This is a preliminary step toward replacing anti-Helmholtz coils in a MOT with a more dynamic field generator. Supported by Swarthmore College.

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LMA18 - **A New Apparatus for Studying Fast Recombination in Ultracold Neutral Plasma,** *Lucas J. Willis, Michael J. Lim; Rowan University, Glassboro, NJ 44601.* We have constructed an apparatus for measuring atomic recombination rates in the early lifetime of an ultracold neutral rubidium plasma. The goal of this work is to experimentally verify theory that predicts measurable three-body recombination on the timescale of a few plasma oscillation periods. Supported by Research Corporation.

LMA19 - **Temperature Dependence of Macromolecule Diffusion by Light Scattering,** *Thomas Akin, Surendra Singh; University of Arkansas, Fayetteville, AR 72701.* Brownian motion of macromolecules suspended in a liquid medium was studied by laser light scattering technique. Measurements of time-dependent intensity correlations of scattered light were used to determine the size of macromolecules and study the temperature dependence of their diffusion. Supported by NSF REU and Arkansas Biological Institute.

LMA20 - **Obtaining Small Beam Radiation Dosage Information Using Gafchromic Film,** *Aatish Bhatia[1], Carl Grossman[1], Paul Sullivan[2], Brian Hasson[2]; 1) Swarthmore College, Swarthmore, PA 19081, 2) Abington Memorial Hospital, Abington, PA 19001.* We built a laser based raster-scanning device that measures absorbance. Gafchromic films polymerize and change colour upon exposure to radiation. We exposed films to small radiation beams and scanned them to determine their dosage gradients. This information has applications for treatment planning in radiation oncology. Supported by Howard Hughes Medical Institute.

LMA21 - **Development of a Fast Position-Sensitive Laser Beam Detector,** *Isaac Chavez, Mark G. Raizen, Ernest-Ludwig Florin, Rongxin Huang; University of Texas Austin, Austin, TX 78712.* We report the development of a position-sensitive laser beam detector with a bandwidth that exceeds commercially available quadrant detectors by more than two orders of magnitude. This detector will be used to study Brownian motion of particles on a fast time scale with near-atomic scale resolution, as well as other applications.

LMA22 **- Generating Holographic Gratings that Produce High Intensity Laguerre Gaussian Beams,** *Monique Calhoun[1], Nicholas Bigelow[2], Andrew Kowalik[2], Suzanne Leslie[2], Kevin Wright[2]; 1) Hampton University, Hampton, VA 23668 2) University of Rochester, Rochester, NY 14620.* In our experiments, we wish to use Laguerre-Gaussian beams to rotate a Bose-Einstein condensate (BEC). The purpose of this study was to create film gratings and an LCD grating that would produce quality Laguerre-Gaussian beams with high intensity in the desired mode. Supported by NSF.

LMA23 **Absorption and Fluorescence Imaging of a Magneto-Optical Trap,** *Daniel Forman[1], Frank Moscatelli [1], Jinwei Wu[2], Eun Oh[2]; 1) Swarthmore College, Swarthmore, PA 19081, 2) Naval Research Labs, Washington, DC 20375.* We have designed and constructed a computer controlled system for the imaging of ultracold atoms. Such a system allows for the determination of both the temperature and size of the MOT.

LMA24 - **Nonlinear Optical Studies of Mesoscopic Particle Surface Charge,** *Allison K. Pymer[1], R. Kramer Campen[2], Satoshi Nihonyanagi[1], Oleksandr Isaienko[1], Eric Borguet[1]; 1) Temple University, Philadelphia, PA 19122, 2) Pennsylvania State University, State College, PA 16802.* Surface charge, a key property determining the interactions of particles in colloidal systems, has been difficult to measure directly. Previous studies using titration and zeta potential measurements made only indirect quantifications. We determined the surface potential at silica-aqueous interfaces *in situ* by second harmonic generation supplemented with classical titration experiments. Supported by the ACS-PRF and the Diamond Scholars Program at Temple University.

LMA25 - **Representation of Rays and Waves in Convex Cavities in Terms of Angle and Impact Parameter,** *Oscar D. Herrera, Miguel Alonso, Seongkeun Cho; University of Rochester, Rochester, NY 14620.* We studied the connection between rays and waves inside convex cavities by using representations in terms of direction and impact parameter. Our goal is to propose a scheme for building wave solutions based on rays. Supported by NSF-REU.

LMA26 - **Accessing Cell Heating During Optical Stretching,** *Carolyn L. Posey, Russell P. Wolfe, and Michael G. Nichols; Creighton University, Omaha, NE 68178.* The optical stretcher is a novel biophotonic device capable of trapping and stretching individual biological cells. Here we compare measurements of Laser-induced heating of individual cells measured by two independent techniques, Raman spectroscopy of water and spectroscopy of Laurdan, a membrane-bound fluorescent probe. Supported by NCRR of the NIH.

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

Session LMB: 2:00 - 3:45 PM, Highland J Room - Martin Richardson, UCF, Presider

LMB1 - 2:00 PM - **Computer Simulations of Electrodynamic Trapping of Polar Molecules,** *Derek Vigil[1], Chris Haimberger[2], Michaela Tscherneck[2], Jan Kleinert[2], Nicholas Bigelow[2]; 1)University of Illinois Urbana/Champaign, Urbana, IL 61801, 2) University of Rochester, Rochester, NY 14620.* Trapping of polar molecules is an area of increasing interest due to its potential uses in quantum information applications and in fundamental physics studies. We report on the simulated stability conditions of a proposed electrodynamic trap for several polar molecules of interest, e.g. NaCs, KRb. Supported by the NSF-REU.

LMB2 - 2:15 PM - **Effect of Experiment Duration on Fluorescence Blinking Statistics from Single CdSe Nanorods,** *Thomas Emmons[1], Siying Wang[2], Claudia Querner[2], Marija Drndic[2], Catherine H. Crouch[1]; 1) Swarthmore College, Swarthmore, PA 19081, 2) University of Pennsylvania, Philadelphia, PA 19104.* We determined fluorescence intermittency statistics from single CdSe nanorods for varying lengths of time. Fitting on-time probability distributions to a truncated power law, we find that with increasing experimental length, the probability distributions for individual rods increasingly resemble the distributions obtained by aggregating 100 rods. Supported by HHMI (Swarthmore College) and NSF and ONR (University of Pennsylvania).

LMB3 - 2:30 PM - **Polarization Self-Modulation in Semiconductor Lasers with Delayed, Rotated Optical Feedback,** *Guinevere Burner, Taylor McLachlan, John Miller, Jake Amonette, David W. Sukow; Washington and Lee University, Lexington, VA 24450.* Polarization-rotated optical feedback, where the linear polarization state of the feedback is perpendicular to the natural laser mode, gives rise to emission of both natural and orthogonal polarization modes, resulting in periodic square-wave oscillations. Supported by NSF CAREER Grant #0239413.

LMB4 - 2:45 PM - **Biomechanical Studies of Living Cells using the Optical Stretcher,** *Russell P. Wolfe, Carolyn L. Posey, Michael G. Nichols; Creighton University, Omaha, NE 68178.* The optical stretcher is a novel biophotonic device capable of trapping and stretching individual biological cells. A geometrical optics model of force generation is used to determine cellular elasticity. The consequences of laser induced heating, as measured by Raman scattering and a fluorescent probe, are carefully considered. Supported by NCRR of NIH.

LMB5 - 3:00 PM - **Non-Local Manipulation of Polarization-Entangled Photons using Geometric Phase,** *Mehul Malik, Brad Melius, Kiko Galvez; Colgate University, Hamilton, NY 13346.* This experiment describes the additive dependence of photons in a polarization-entangled state on their geometric phase. It is carried out by manipulating the phase between the horizontal and vertical components of polarizations for a pair of down-converted photons. The dependence on geometric phase is explained and verified using two methods. Supported by NSF.

LMB6 - 3:15 PM - **A Search for Variation of the Fine-Structure Constant in Atomic Dysprosium,** *N. Leefer[1], A. Cingöz[1], A. Lapierre[1], D. Budker[1], A.-T. Nguyen[2], S. Lamoreaux[2], J. Torgerson[2]; 1) University of California Berkeley, Berkeley, CA 94720, 2) Los Alamos National Laboratory, Los Alamos, NM 87545.* This experiment monitors the transition frequency between two nearly degenerate opposite-parity states in atomic dysprosium (Dy). Recent calculations have shown that these levels are highly sensitive to variation of the fine-structure constant, α. Supported by NIST, LANL, and Foundational Questions Institute.

LMB7 - 3:30 PM - **Direct UV Writing of Waveguides in Lithium Niobate,** *N. Woodward[1], D. Newby[1,2], V. Dierolf[1], D. McGee[1,2]; 1) Lehigh University, Bethlehem, PA 18015, 2) Drew University, Madison, NJ 07940.* We studied the creation of optical waveguides in $LiNbO_3$ by a focused 244 nm laser beam utilizing Raman and rare earth emission spectroscopy. Supported by NSF-REU, NSF-Europe (DMR-349632), and MWN (NSF-DMR-0602986).

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Session LME: 4:15 – 6:15 PM, Highland B Room - Volkmar Dierolf, Lehigh Univ., Presider

LME1 - 4:15 PM - **Measuring Photon Mass Using Ion Interferometry,** *Dan Christensen, Brian Neyenhuis, Ross Spencer, Dallin S. Durfee; Brigham Young University, Provo, UT 84602*. We will discuss a novel ion-interferometry scheme which should enable measurements of a possible photon rest mass more than 100 times smaller than previous experiments. The experiment would search for deviations in Coulomb's inverse-square law using an ion interferometer. Analytical and numerical computations will be presented. Supported by BYU's Physics Department and Office of Research and Creative Activities.

LME2 - 4:30 PM - **Incoherent Spectral Beam Combining of Yb-Doped Fiber Lasers,** *Ryan Kinney[1], A. Tünnermann[2], J. Limpert[2], B. Ortaç[2], S. Klingebiel[2]; 1) University of Missouri, Rolla, MO 65409, 2) Friedrich-Schiller University, Jena, Germany.* Spectral combining of two ytterbium doped fiber lasers in a MOPA configuration is demonstrated with a tunable range from 1020 to 1044 nm. Here, ten beams can be combined to produce a near diffraction limited beam and a possible output power in excess of 1000 W. Supported by NSF.

LME3 - 4:45 PM - **FRET Between Prestin Monomers Detected by Fluorescence Lifetime Imaging,** *Meg M. Marquardt[1], Richard Hallworth[2], Michael G. Nichols[1]; 1) Creighton University, Omaha, NE 68178, 2) School of Biomedical Sciences, Creighton University, Omaha, NE 68178.* Prestin is an essential auditory protein found in the membrane of outer hair cells of the cochlea; mammals that lack prestin are essentially deaf. Optical techniques such as FRET and FLIM are used to study co-localization of prestin proteins to investigate the formation of functional groups. Supported by NCRR (P20 RR16469) of NIH, and Nebraska Center for Cell Biology (NSF EPSCoR)

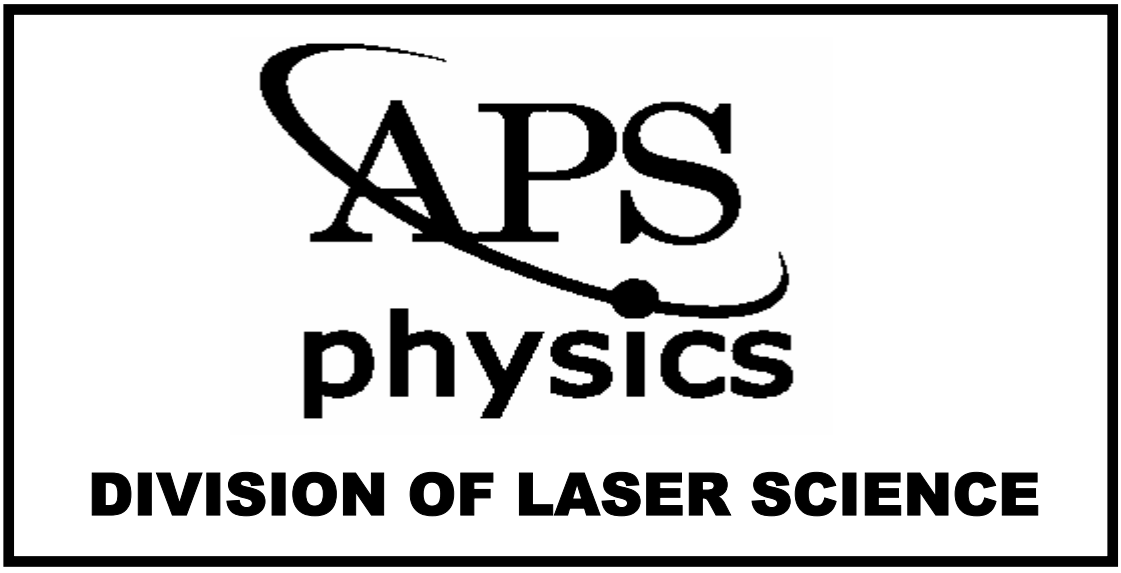
LME4 - 5:00 PM - **Development of a Variable Repetition Rate for a Deep UV Laser,** *J.P. Wilson[1], G.M. O'Connor[2], C. Mullan[2]; 1) University of Florida, Gainesville, FL 32611, 2) National Centre for Laser Applications, National University of Ireland-Galway, Ireland.* The development of novel ways to control lasers externally is important for numerous applications. Using repetitively-pulsed, deep UV-DPSS lasers and external acousto-optic modulators, a method for repetition rate reduction was developed. A data flow program was implemented in LabView, creating a system with lower repetition rates and stable pulse energies. Supported by the NSF-REU, #EEC-0244109, #DMR-031208, NCLA and NUI Galway.

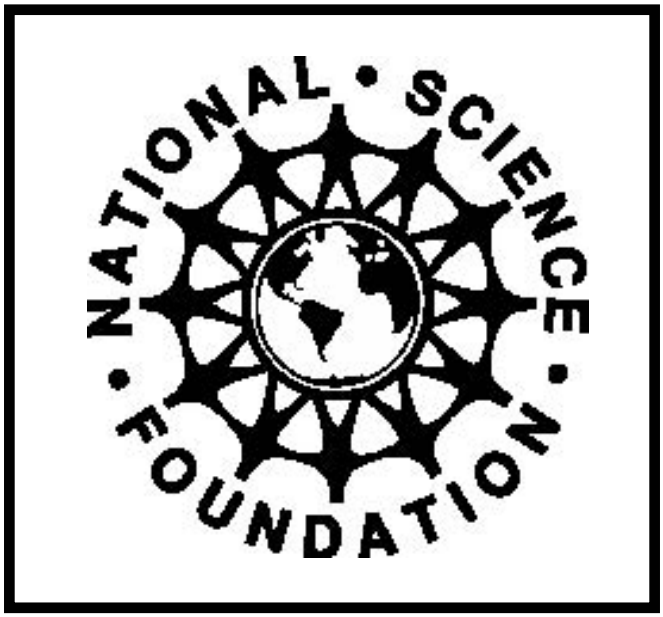
LME5 - 5:15 PM - **Measurement, Analysis and Theoretical Basis of Power Distribution in Diffraction Gratings as a Function of Incident Angle,** *Raghav K. Chhetri, Michael E. Goggin; Truman State University, Kirksville, MO 63501.* Overall efficiency measurements with respect to angle of incidence were taken for diffraction gratings having 1200 grooves per mm. These measurements indicate serious power loss as a function of incident angle and wavelength. The data agree with existing theories of Wood's anomalies and plasmon-light coupling in gratings. Supported by Truman State University.

LME6 - 5:30 PM - **Determination of the Destruction Threshold of Optical Coatings,** *Cassy Davison[1], Elizabeth Voigt[2], Toursten Mans[3], Peter Russbueldt[3]; 1) Norfolk State University, Norfolk, VA 23504, 2) Kansas State Univeristy, Manhattan, KS 66506, 3) Fraunhofer Institute for Laser Technology, Aachen, Germany.* The destruction threshold of optical coatings limits the maximum power of laser systems. This paper compares destruction thresholds for various substrate polishes and coatings on YAG and Yb:KGW crystals. Destruction thresholds as high as 1.34 TW/cm^2 for YAG and 1.40 TW/cm^2 for YB:KGW were achieved. Supported by NSF and UCF-CREOL.

LME7 - 5:45 PM **Minimizing the Distortion of a Pulse Propagating through a Slow Light Medium,** *Katie Schwertz, Heedeuk Shin, George Gehring, Aaron Schweinsberg, Robert W. Boyd; University of Rochester, Rochester, NY 14620.* We investigate the distortion of a pulse on a continuous wave background and observe the dependence of this distortion on pulse width, intensity of signal and pump beam, and signal to background ratio. While increasing pulse width and pump power cause pulse broadening, adding a background offsets this distortion. Supported by NSF.

LME8 – 6:00 **A Nuclear Magnetic Resonance (NMR) Gyroscope,** *Daniel D. Hickstein, Elizabeth Donley; NIST, Boulder, CO 80305.* NMR gyroscopes have the potential to bring navigational-grade rotation sensing from the 10 cm-scale to the chip-scale. We have demonstrated, in a tabletop apparatus, the spin-exchange optical pumping of xenon and its precession in a magnetic field, the two essential capabilities of our proposed NMR gyroscope. Supported by DARPA and NSF-REU.





This event organized by
Harold Metcalf, DLS chair
with help from
John Noé and Azure Hansen
Stony Brook University