SYMPOSIUM ON UNDERGRADUATE RESEARCH

Division of Laser Science of A.P.S. - LS XXIX - 7 October 2013 - Orlando, FL

PARTICIPANTS' LUNCHEON - Ballroom Salon XII-12:00

The participants' luncheon will bring together the Symposium students and distinguished laser scientists, including Lou DiMauro, Henry Kapteyn, M. J. Soileau, and David Wineland

Box lunches will be provided for participants and invited guests only.

POSTER SESSION - Ballroom Foyer - 12:30

Session LM2A: 12:30 - 2:55 PM, Ballroom Foyer, Anne Kelley, U. C. Merced, Presider

LM2A-1 - Characterization of the Log-Negativity of a Transmon-Transmission Line System's Steady-State Using a Circuit QED Model, *Robert Rogers and Perry Rice, Miami University, Oxford, OH 45056.* Following previous work in the field, a circuit QED model is used to theoretically describe the behavior of a transmon-transmission line system. The log-negativity of the steady-state of the system is characterized for high driving. The discussion includes an introduction along with preliminary results. Supported by Miami University USS and Dean's Scholar programs.

LM2A-2 - Polarization Dynamics of a Current-Modulated Vertical-Cavity Surface-Emitting Laser (VCSEL) Subject to Optical Feedback, *Aliza Khurram, Spencer Goossens, and Hong Lin, Physics and Astronomy, Bates College, Lewiston ME, 04240.* We studied the polarization dynamics of a VCSEL by varying several control parameters. Resonance between modulation and feedback was observed in the single transverse mode operation. Modulation and feedback dynamics always coexisted in the multimode regime. Supported by NSF.

LM2A-3 - Photothermal Imaging: Detecting Nanoparticles with Absorption, *Kathilee Kenlock and Michael E. Durst, Physics and Astronomy, Bates College, Lewiston, ME 04240.* Photothermal imaging can reveal objects which absorb but do not emit light. This absorption leads to photothermal heating of the surrounding medium, and the resulting change in refractive index is detected using a pump-probe experiment. Supported by the Bates College Mount David Research Fellowship.

LM2A-4 - Optical Tweezers: From Atoms to Microspheres, *Albert Shi and Michael E. Durst, Physics and Astronomy, Bates College, Lewiston, ME 04240.* An optical tweezer apparatus consisting of a trapping laser and imaging system has been developed for the study of dielectric microspheres of varying diameters. The physical principles of the trap and how it can be adapted to the atomic level will be discussed. Supported by the Bates College Mount David Research Fellowship.

LM2A-5 - Development of a 1D Optical Lattice for Studying Analog Solid-State Physics With Bose-Einstein Condensates, *Nathan Lundblad, Yang Guo, Bates College, Lewiston, ME 04240.* In this work we generate ^{87}Rb Bose-Einstein condensates in a combined magnetic and optical potential, then load the BECs into a 1D optical lattice, where Kapitsa-Dirac diffraction is observed. The optical lattice will be used to study analog solid-state systems, including the use of radiofrequency coupling to generate spin-dependent lattices with novel structure.

LM2A-6 - Optical Harmonic Generation in Gold Nanorods, *Olalekan Afuye and Michael E. Durst, Department of Physics and Astronomy, Bates College, Lewiston, ME 04240.* Using both a theoretical and experimental approach, we investigate the effect of gold nanorods' size, orientation, and coupling modes along with the polarization of incident excitation light on the second- and third-harmonic generation (THG) signal. Theoretical results based on finite-difference time-domain (FDTD) simulations will be discussed. Supported by the Bates College Pribram/Ruff Fund.

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LM2A-7 - Observations of Radio-Frequency Noise on an Extended-cavity Diode Laser (ECDL), *Enoch Lambert, James Archibald, and Dallin Durfee, Brigham Young University, Provo, UT 84604.* Radio-frequency noise on ECDLs may provide a signal allowing for low-cost, long-term stable operation. We present observations of this noise on a simple ECDL setup, plus techniques for reading and processing the noise signal. Supported by Brigham Young University and NSF.

LM2A-8 - Stimulated Raman Scattering and Four-Wave Mixing in H_2CO mixtures and Magnegas, *Kamonasish Chakraborty, Mikhail Sharonov, Yury Budansky, and R.R. Alfano, The City College of New York of the City University of New York NY 10031.* Stimulated Raman Scattering (SRS) spectra from vibrational, rotational and four-wave mixing (FWM) was measured using the Second-Harmonic of a Q- switched Nd:YAG laser at 20 atm in H_2CO mixture and Magnegas. The SRS spectra are strikingly similar and explained using the vibrational and rotational modes of pure hydrogen gas. Supported by Magnegas Corporation.

LM2A-9 - Progress Towards the Creation and Detection of Rubidium-85 Feshbach Molecules, *Elana Urbach, Charles Fancher, Isabelle Lee, Austin Ziltz, Megan Ivory, Anuraag Sensharma, and Seth Aubin, College of William and Mary, Williamsburg, VA 23187.* An apparatus including a magneto-optical trap, magnetic trap, and dual laser dipole trap has been modified for studies of the 155 G Feshbach resonance and associated production of ultracold Rubidium-85 molecules. Modifications include the construction of an external cavity diode laser to potentially aid in molecule detection. Supported by VSGC.

LM2A-10 - Multiphoton Fluorescence with Simultaneous Spatial and Temporal Focusing, *Saad Ansari and Michael E. Durst, Physics and Astronomy, Bates College, Lewiston, ME 04240.* Simultaneous spatial and temporal focusing (SSTF) creates optical sectioning in multiphoton fluorescence imaging by varying the excitation pulse width with position. A grating in a 4f lens telescope separates the various frequencies in space before they are recombined at the focus of an objective lens. Supported by the Bates College Mount David Research Fellowship.

LM2A-11 - Development of a Self-Heterodyne Linewidth Measurement System, *Nathan Abrams[1] and Elizabeth Donley[2], 1) Columbia University, New York, NY 10027, 2) National Institute of Standards and Technology, Boulder, CO 80305*. A compact cold-atom clock based on coherent population trapping with phase-locked lasers is being developed. To assist in characterizing the AC Stark Shift and in improving a frequency stabilized laser loop, a self-heterodyne measurement system was developed and the laser spectra were measured. Supported by NIST.

LM2A-12 - Parallelizable Algorithms for Describing the Effects of Strong Time-Dependent Electromagnetic Fields on the Hydrogen Atom, *John Emmons, Austin Howes, Alexander Kramer, Xiaoxu Guan, Jason Grout, and Klaus Bartschat, Drake University, Des Moines, IA 50311.* Exposure to infrared rather than vacuum-ultraviolet radiation requires long propagation times to solve the time-dependent Schrödinger equation for this fundamental strong-field problem. We report progress on developing a computer code that makes such calculations possible on massively parallel supercomputer platforms. Supported by NSF.

LM2A-13 - Long-Wavelength Multiphoton Microscopy, *Erin Curry and Michael E. Durst, Physics and Astronomy, Bates College, Lewiston, ME 04240.* A two-photon microscope has been developed for noninvasive imaging of biological tissue. We use a long-wavelength femtosecond fiber laser for multiphoton excitation of fluorescent dyes. Supported by the Bates College STEM Fellowship and by the NIH through an IDeA award.

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LM2A-14 - Simulating the Interaction between Atom Clouds and Laguerre-Gaussian Laser Beams, *Stefan Evans and Harold Metcalf, Physics and Astronomy, Stony Brook University, Stony Brook, NY 11794-3800.* Electric quadrupole transitions in atoms require $\Delta\ell=2\hbar$ but ordinary light carries angular momentum of only $1\hbar$. However, Laguerre Gaussian(LG) beams possessing orbital angular momentum can have arbitrary angular momentum. We simulate the obstruction of LG beams of various ℓ to investigate their effect on clusters of absorbing atoms.

LM2A-15 - Developing Dark-Ground Imaging on an Atom Chip, *A. Sensharma and S. Aubin, Physics, College of William and Mary, Williamsburg, VA 23187*. Dark-ground imaging modifies absorption imaging by using Fourier spatial filtering to block probe beam light that is not diffracted by the imaged sample, eliminating the bright background from the image. We present progress on using an imaging system based on this technique to image ultracold atoms on an atom chip.

LM2A-16 - Development and Fabrication of a Schmidt Telescope to Validate Nodal Aberration Theory Applied to Freeform Surfaces, *Isaac Trumper, Kyle Fuerschbach, and Jannick P. Rolland, The Institute of Optics, Univ. of Rochester NY 14627.* Nodal aberration theory (NAT) predicts the aberration field behavior for freeform surfaces. A Schmidt telescope was developed to experimentally validate these predictions for a commonly observed effect, three point mount-induced error. The fabrication and metrology of key components is presented. Supported by the R.E. Hopkins Center, NSF, and the II-VI Foundation.

LM2A-17 - Production of an ^{87}Rb BEC in a Hybrid Magnetic-Optical Trap, *Joanna Moody, Edward Moan, Nathan Lundblad, Bates College, Lewiston, ME 04240.* A Zeeman-slowed ^{87}Rb atomic beam undergoes magneto-optical trapping and sub-Doppler cooling before being transferred into a quadrupole magnetic trap where it is evaporatively cooled. Further evaporation is forced in an optical trap, leading to densities and temperatures that yield BEC to be used in future optical-lattice experiments

LM2A-18 - A Simple Model of a Feshbach Resonance, *I. Lee and S. Aubin, Physics, College of William and Mary, Williamsburg, VA 23187.* We investigate the basic physics of Feshbach resonances with a toy model for the inter-atomic scattering potential. We find that a spherical well potential reproduces the qualitative behavior of Feshbach resonances. We also observe that the Feshbach resonances depend on the momentum, and thus, the energy of the incoming particle.

LM2A-19 - Dipole-dipole Interaction Between Rubidium Rydberg Atoms, *Rachel Feynman[1], Thomas Carroll[2] and Michael W. Noel[1], 1) Bryn Mawr College, Bryn Mawr, PA 19010, 2) Ursinus College, Collegeville, PA 19426.* We excite ultracold rubidium atoms to Rydberg states by focusing two diode lasers on a magneto-optical trap. The Stark effect tunes energy exchange between atoms into resonance at specific values of the electric field, which we scan while measuring how many interact. We present several dipole-dipole interaction spectra. Supported by NSF and Bryn Mawr's summer research program.

LM2A-20 - Generating Robust Forces by Pulsed Adiabatic Rapid Passage on Metastable Helium, *James Dragan, John Elgin, and Harold Metcalf, Physics, Stony Brook University, Stony Brook NY 11794-3800.* Adiabatic rapid passage is used to produce optical forces much stronger than the ordinary radiative force. Using the 2^3S -2^3P transition in metastable helium we show our measurements of such optical forces. To determine their velocity spread we mimic the atomic motion through detuning that stimulates Doppler shifts. Supported by the Office of Naval Research

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LM2A-21 - Creating Improved Optical Vortex Beams with a Spiral Phase Plate, *Rachel Sampson, Stefan Evans, Martin G. Cohen, and John Noé, Physics and Astronomy, Stony Brook University, Stony Brook, NY 11794-3800*. We investigate the formation and propagation of optical vortex beams created with an ℓ = 1-8 spiral phase plate (RPC Photonics, Rochester). Illuminating the plate with an annular apodized wavefront produced by Fresnel diffraction should improve the quality of the vortex beams, making them closer to pure LG modes. Supported by the Stony Brook Laser Teaching Center and the Simons Foundation.

LM2A-22 - Can C. elegans Detect Light: A Novel Method, *Tewa Kpulun, Hayley Lemoine, Alicia Jago, Jenny Magnes , Kathleen Susman, Vassar College, Poughkeepsie, NY 12604*. C. elegans are freely swimming nematodes that live in bacteria-rich environments. Our research aims to explain their ability to detect different wavelengths of light and exhibit a behavioral response. Instead of using traditional microscopic techniques, we used 10 mm optical cuvettes to mimic their environment. Supported by Vassar College Undergraduate Research Summer Institute, Lucy Maynard Salmon Research Fund, and NSF.

LM2A-23 - Energy Exchange Among Rydberg Atoms, *– Erin C. Bennett[1], Tamas A. Budner[1], Michael A. Giongo[1], Tyler J. Helms[1], Donald P. Fahey[2], Michael W. Noel[2], Thomas J. Carroll[1]. 1) Ursinus College, Collegeville, PA 19426, 2) Bryn Mawr College, Bryn Mawr, PA 19010.* We simulated energy exchange among spatially separated groups of ultra-cold atoms. These atoms are excited to Rydberg states; one group can interact with other groups, but those groups cannot exchange energy with each other. We vary experimental parameters, such as electric field, and present the simulation results. Supported by NSF, Bryn Mawr College, and Ursinus College.

LM2A-24 - Design and Characterization of Pulsed Valve for Deflection/Cooling of CaF via Bichromatic Forces, *Tony Le, Scott Galica, Leland Aldridge and Edward E. Eyler, University of Connecticut, Storrs, CT 06269*. A laser ablation setup for a calcium monofluoride source was designed and constructed to be used with a homemade or commercial pulsed valve. The pulsed valve is being characterized by laser-induced fluorescence in preparation for deflection and slowing experiments on CaF. Supported by NSF.

LM2A-25 - Characterizing Lasers for Cooling, *Nicole Cronin[1], Justin T. Schultz[2], Marek Haruza[2], Azure Hansen[2], Nicholas P. Bigelow[2], 1) Muhlenberg College, Allentown PA 18104, 2) University of Rochester, Rochester NY 14627.* We use a Fabry Perot cavity and a HeNe laser to measure the linewidth and center frequency of a home-built interference-filter-stabilized external cavity diode, for use in imaging and manipulating a Bose-Einstein condensate. Supported by NSF and the University of Rochester.

LM2A-26 - Tuning the Energy Exchange among Rydberg Atoms, - *Michael Giongo[1], Tyler Helms[1], Erin Bennett[1], Tamas Budner[1], Donald P. Fahey[2], Michael W. Noel[2]; Thomas J. Carroll[1], 1) Ursinus College, Collegeville, PA 19426, 2) Bryn Mawr College, Bryn Mawr, PA 19010.* We observe the dipole-dipole energy exchange among Rydberg atoms. This process involves running simulations on multiple groups of atoms equally spaced along a line. We will present the results of what happens to the energy exchange among these atoms when the electric field gradient and separation between groups are varied. Supported by NSF, Bryn Mawr College, and Ursinus College.

LM2A-27 - Measurements Using Cold ^{7}Li Atoms in a Visible Magneto-optical Trap, *Dan Mohr[1], Chad Hoyt[1], and R. Jason Jones[2], 1) Bethel University, St. Paul, MN 55112, 2) College of Optical Sciences, University of Arizona, Tucson, AZ 85721-0094.* We report progress toward a low-cost, high performance erbium fiber laser frequency comb for use in undergraduate advanced laboratories and research. A nonlinear polarization rotation mode-locked erbium laser was built and characterized in the context of an open-ended project in a lasers course at Bethel. Supported by NSF.

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LM2A-28 - Zeeman Effects in a Short HeNe Laser, *Casey McKenna, David Battin, Samuel Goldwasser, and John Noé, Physics and Astronomy, Stony Brook University, Stony Brook, NY 11794-3800.* We observed longitudinal modes and mode beats in a short HeNe laser in a ~300 Gauss axial magnetic field. The neon gain curve splits into two overlapping branches, which produce sigma+/- polarized light, respectively. Modes that sweep into the overlap region are split by ~1 MHz by mode pulling. Supported by the Stony Brook Laser Teaching Center and the Simons Foundation.

LM2A-29 - Creating a Cavity-Dumped Helium-Neon Laser, *Kevin Zheng[1,2], Martin G. Cohen[2], and John Noé[2], 1) Wayzata High School, Plymouth, MN 55311, 2) Physics and Astronomy, Stony Brook University, Stony Brook, NY 11794-3800.* We use an acousto-optic modulator to quickly extract circulating power from a 1.4 m open-cavity HeNe oscillator. We can extract 100 ns pulses with maximum peak power ~2 mW at a repetition rate of 100 kHz. We can attain repetition rates of over 1 MHz with decreased peak power. Supported by the Stony Brook Laser Teaching Center and the Simons Foundation.

LM2A-31 - Evolving Optical Caustics Formed by Evaporating Water Droplets, *Samantha Scibelli, Melia Bonomo, and John Noé, Physics and Astronomy, Stony Brook University, Stony Brook, NY 11794-3800.* Berry and Nye have each discussed the connections between the complex patterns of optical caustics and the mathematical catastrophe theory of René Thom. In this study we observed and mathematically modeled the evolution of caustics created by passing a laser beam through the irregular edges of evaporating water droplets. Supported by the Stony Brook Laser Teaching Center and the Simons Foundation.

LM2A-32 - Optimizing Trapping Efficiency in Optical Tweezers, *Katherine Camenzind, Martin G. Cohen, and John Noé, Physics and Astronomy, Stony Brook University, Stony Brook, NY 11794-3800.* Trapping efficiency in optical tweezers depends in part on the beam intensity profile. We studied trapping with ~10 mW HeNe beams of three diameters and annular (vortex) beams of order ℓ = 1-8 in an inverted tweezers setup. Transverse trapping forces on 10 μm latex spheres were quantified by the drag-force method. Supported by the Stony Brook Laser Teaching Center and the Simons Foundation.

LM2A-33 - Measuring the Index of Refraction of Thin Layers Using an External Cavity Diode Laser and Rubidium Spectroscopy. *Chris Luetjen, Jonathan Hallsted, and Michaela Kleinert. Willamette University, Salem, OR 97301.* Using a simple and inexpensive extended cavity diode laser set-up, we have devised a novel way to measure the index of refraction of thin layers. We tested water, vegetable oil and air, and all of our measurements demonstrated excellent agreement with accepted values.

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

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Session LM3G: 3:00 - 4:15 PM, Bonnet Creek Ballroom XII - Samir Bali, Miami University, Presider

LM3G-1 - Second Harmonic and Optical Parametric Generation in KDP Using Supercontinuum Light from a Photonic Crystal Fiber, *Zabir Hossain, Yisa Rumala, Leor Gayr, and Robert .R. Alfano, City College of New York, New York, NY 10031.* The supercontinuum output generated by a photonic crystal fiber is passed through nonlinear crystal to produce second harmonic and other frequencies ranging from the visible to ultraviolet. Supported by Army Educational Outreach Program (AEOP).

LM3G-2 - Design and Construction of Cost-effective Fail-safe Tapered Amplifier Systems for Laser Cooling and Trapping Experiments, *Ethan Clements, A. J. Hachtel, M. C. Gillette, J. C. B. Kangara, J. T. Barkeloo, J. D. Kleykamp, and S. Bali, Physics, Miami University, Oxford OH 45056.* We present detailed plans for the construction of a home-built tapered amplifier (TA) system. Instructions are provided on all relevant practical aspects of system and user safety. We include measurements of the TA output through a single-mode optical fiber as a function of seed intensity, polarization, and driving current. Supported by Petroleum Research Fund, Miami University

LM3G-3 - Diffraction Intensity Calibrations, *Ramy H. Abbady, Brian Deer, and Jenny Magnes, Vassar College, Pougkeepsie, NY 12604.* Motivated by the study of charge densities on diffraction, the relationship between diffraction pattern intensities and incident laser power is investigated. The possibility of a non-linear relationship is investigated using single slit diffraction. Possible causes of this effect are being investigated experimentally. Results and future experimentation are discussed. Supported by NSF Grant for Physics of Living Physical Systems.

LM3G-4 - Photodiode Wavelength Meter, *Tyler Jones, Nils Otterstrom, Kevin Blisset, Jarom Jackson, Dallin Durfee, Brigham Young University, Provo, UT 84602.* A wavelength meter has been constructed using an array of photodiodes. The wavelength of light is calculated based on the relative intensities on the diodes. This project focuses on improving measurement precision. The method and precision will be discussed. Supported by Brigham Young University and NSF.

LM3G-5 - Time Independent Approach to Semiclassical Dynamics, *Rebecca Weirauch, Chris H. Greene, Purdue University, West Lafayette, IN 47907.* A program was developed to investigate the quantum dynamics of a Gaussian wave packet moving in a variety of potentials. The program applies a specific Hamiltonian to control the motion of an original Gaussian. Two numerical methods have been used, the Runge-Kutta method and the Chebychev method. Supported by NSF.

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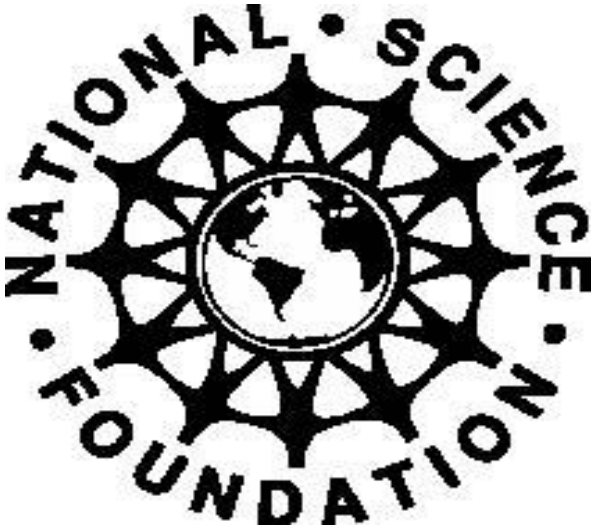
Session LM4G: 4:30 – 5:30 PM, Bonnet Creek Ballroom XII –Jenny Magnes, Vassar College, Presider

LM4G-1 - Empirical Model of Total Internal Reflection from Highly Scattering Opaque Media: Application to Nano Aggregation, *Patrick Judge, Diane Beamer, Kashika Goyal, Miao Dong, Marcel Nguemaha, William Calhoun, Lalit Bali, and Samir Bali, Miami University, Oxford, OH 45056.* We demonstrate an empirical model for reflectance measurements from highly scattering media, which enables accurate in-situ particle sizing using standard Mie calculations. We investigate the possibility of real-time detection of aggregation in gold nanoparticle suspensions. Supported by Petroleum Research Fund and Miami University.

LM4G-2 - Ultrafast Optics and High Performance Frequency Combs in the Undergraduate Advanced Laboratory, *Dan Mohr, Dan Klemme, Jay Brooks, Caleb Logemann, and Chad Hoyt; Bethel University, St. Paul, MN 55112.* We present measurements of cold ^{7}Li atoms in a magneto-optical trap based on an external cavity diode laser at 671 nm. We recorded the fluorescence spectrum of the unresolved D_2 lines in cold ^{7}Li. We observed line shape effects due to probe beam polarization, power broadening, and probe duration. Funded by CID, Inc., Bethel University, and the NSF.

LM4G-3 Coherent Population Trapping in a Lambda-configuration of ^{87}Rb, *Tianchu Liang and John Brandenberger, Lawrence University, Appleton, WI 54911*. In an application of Coherent Population Trapping (CPT) involving ^{87}Rb and the $5S_{1/2}$ F=(1,2) ---> $5P_{1/2}$ F=2 transitions, we have investigated the dependences of the widths and relative depths of CPT-dips as a function of laser power. To help inform our investigation, we have generated theoretical CPT line shapes derived from a three-state density matrix analysis. Supported by a Dale L. Skran, Sr. Summer Research Fellowship.

LM4G-4 Stimulated Laser Slowing of Atoms Using Narrow Atomic Transitions, *Nikhil Raghuram, TianMin Liu and Leo Hollberg, Stanford University, Stanford CA, 94305*. Stimulated bichromatic slowing uses amplitude-modulated waves to slow atomic beams with forces greater than the Doppler limit. Through numerical simulations, we investigate the bichromatic slowing of Ytterbium atoms using the green intercombination line. Results indicate bichromatic slowing shows promise as a MOT loading technique.



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