SYMPOSIUM ON UNDERGRADUATE RESEARCH

Division of Laser Science of A.P.S - LS XXXIV - 17 September 2018.- Washington DC

PARTICIPANTS' LUNCHEON - Ballroom East - 12:00

The participants' luncheon will bring together the Symposium students and distinguished laser scientists.

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

REMINDER: Group Photo Break 3:55 PM - PLEASE assemble at the designated place!!!

POSTER SESSION - International Ballroom East - 1:00

Session LM4G (poster) 1:00 - 3:55 PM, Ballroom East – Dr. Keith Stein, Bethel Univ., Presider

LM4G - 1 Using the Instantaneous Velocity of a Brownian Particle in an Optical Tweezer to Measure Changes in Mass. *Gabriel H. Alvarez[1], Julia E. Orenstein[2], Lichung Ha[2], Diney S. Ether Jr.[2], and Mark G. Raizen[2]. 1) Stanford Univ., Stanford, CA 94305, 2) Univ. of Texas, Austin, TX 78712.* Using a fast detector to observe the light deflected by silica microspheres trapped in an optical tweezer, we obtain positional information from which instantaneous velocities are calculated and fit to the Maxwell-Boltzmann distribution to extract mass. We plan to use this technology to characterize the onset of heterogeneous ice nucleation.

LM4G - 2 Optical Tweezing Experiments with Dielectric Microbeads *Willa Dworschack[1,2], Chiu Yin Lee[1], Perri Zilberman[1], Martin Cohen[1], Harold Metcalf [1]1) Stony Brook Univ., Stony Brook, NY 11794, 2) Lawrence Univ., Appleton, WI 54911* Optical tweezing utilizes the momentum carried by light to manipulate micro-scale objects. We designed and constructed an optical tweezing apparatus that enabled precision control of dielectric microbeads using a He-Ne laser and an inverted microscope. Its piconewton force capabilities were demonstrated. Further exploration of the technique's application is discussed. Supported by ONR and the Simons Foundation.

LM4G - 3 Polarization Dynamics of Quantum Dot Lasers with Optical Feedback, *Chen Yang, Salim Ourari, and Hong Lin, Bates College, Lewiston, ME 04240*. We have studied feedback-induced dynamics of a quantum dot laser by observing its power spectra and time series. Dynamics in individual polarizations are stronger than that of the total power because orthogonal polarizations are anti-correlated. Supported by Bates College.

LM4G - 4 Cavity Ringdown Spectroscopy of OH Radical Adducts of Benzene and Toluene, *James Vinson, Joseph Messinger, and Mitchio Okumura, California Institute of Technology, Pasadena, CA 91125.* Spectra of the vibrational OH-stretch of benzene+OH and toluene+OH adducts are obtained via Cavity Ringdown Spectroscopy in order to further understand these atmospherically important precursors to secondary organic aerosols. Future experimental plans to investigate electronic transitions and directly determine branching ratios for addition to toluene are also considered. Supported by NSF.

LM4G - 5 Exploring Structured Light with Orbital Angular Momentum, *Brianna Holmes[1] Sonja Franke-Arnold[2], Pooja Jayachandran[2], and Sarah Croke[2], 1) Colgate Univ., Hamilton, NY 13346, 2) Univ. Glasgow Glasgow G12 8QQ, UK.* A digital micro-mirror device and polarization experiment was used to analyze and image Laguerre-Gaussian beams' intensity and polarization in and away from the far field. Comparing images with theoretical plots, the original beams' azimuthal index number can be identified.

LM4G - 6 Two-color Interferometer for High Harmonic Generation in Solids. *Erin Crites, Shima Gholam-Mirzaei, and Michael Chini, Univ. of Central Florida, Orlando FL 32816.*. We are building a two-color interferometer for femtosecond mid-IR (3-4 μm) pulses and their second harmonic. With this, we can control two-color fields that allow for generation of high-order even harmonics. These can be used to study harmonic generation and characterize attosecond pulses. AFOSR, UCF Undergraduate Research.

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LM4G - 7 Two-Color High Harmonic Generation. *Marc Etienne, John Beetar, Yangyang Liu, Federico Rivas, and Michael Chini, Univ. of Central Florida, Orlando FL 32816.* High harmonic generation is a non-linear process that converts a laser to XUV light. Usually when high harmonics are generated, they are generated in odd orders. This experiment attempts to generate odd and even harmonics with improved efficiency in a two-color field. Supported by AFOSR and UCF EXCEL.

LM4G - 8 Frustrated Tunnel Ionization of Argon by Intense Few-Cycle Infrared Laser Radiation. *Thomas Pauly, Lórien MacEnulty, and Klaus Bartschat, Drake Univ., Des Moines, IA 50311.* We report calculations for strong-field ionization and excitation of argon by directly solving the time-dependent Schrödinger equation in a single-active electron model. We discuss the effect of different potentials and carrier-envelope phases on the theoretical predictions. Our calculations support ongoing experiments at Griffith Univ. (Brisbane, Australia). Supported by NSF.

LM4G - 9 Synchronous Polarization Switching in Mutually Coupled Vertical-Cavity Surface-Emitting Lasers, *Michał Ćwik and Hong Lin, Bates College, Lewiston, ME 04240*. Two vertical-cavity surface-emitting lasers (VCSELs) operating in fundamental modes are coupled via mutual optical injection. Polarization switching and frequency locking can be achieved in both lasers simultaneously. The effect of optical feedback on polarization switching is studied as well. Supported by Bates College.

LM4G - 10 Experimental Generation and Characterization of Non-Interfering Bessel-like Beams, *Edward McManus, Richard A. Sadlon, and Carlos A. Trallero, Univ. of Connecticut, Storrs, CT 06269*. A spatial light modulator and axicon have been utilized to generate two non-interfering bessel-like beams. By using the SLM, the relative optical phase can be adjusted without changing the spatial profile. The potential application to high harmonic generation will also be discussed. Supported by Univ. of CT.

LM4G - 11 In-situ Method for Characterization of Two-Stage Photopolymer Phase Structures. *Emily K. Schwartz[1], John E. Hergert[2], Charles M. Rackson[2], David J. Glugla[2], Amy C. Sullivan[2], and Robert R. McLeod[2], 1) Carleton College, Northfield, MN 55057, 2) Univ. of Colorado, Boulder, CO 80309.* The characterization of the refractive index contrast in two-stage photopolymers, Δn, is essential for optical device design. We present an in-situ imaging technique using confocal reflection microscopy and quantitative phase imaging that captures the full spatial frequency spectrum and Δn of 2D photo-structured phase elements. Supported by NSF.

LM4G - 12 Experimental Violation of Bell's Inequality, *Michael Dapolito, Eric Wu, Christopher Ianzano, and Samet Demircan, Stony Brook Univ., Stony Brook, NY 11794.* A violation of the CHSH Bell inequality is experimentally realized using qutools' Entanglement Demonstrator. To confirm this violation, we rely on the coincident detection of entangled photons with correlated polarizations. A 36 σ violation is given by the measurement's expectation value, +1 (-1) for pairs having equal (opposite) polarization. Supported by Simons Foundation and ONR.

LM4G - 13 Digital Plasmonic Holography. *Ryan M. Spies and Nathan C. Lindquist, Bethel Univ. St. Paul, MN 55112.* Lensless in-line digital holographic imaging techniques have been implemented with surface plasmon waves in a novel form of surface microscopy. We optimize this process via computer simulations by adapting phase retrieval algorithms from standard 3-D digital holography methods to the 2-D propagating plasmon waves. Supported by NSF.

LM4G - 14 Characterization of Indium Gallium Nitride Electronic Structure Using Linear Spectroscopy. *Haley Reid[1], Rachel Owen[2], and Steven Cundiff[2], 1) Florida State Univ.Tallahassee, FL 32306 2) Univ. of Michigan, Ann Arbor, MI 48109.* The process of studying the semiconductor Indium Gallium Nitride using absorption and photoluminescence spectroscopy shows physical characteristics of the band gap and exciton peaks and gives insight to many body effects in the semiconductor. Supported by NSF.

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LM4G - 15 Design for a Self-Injected Single Frequency Ti:sapphire Laser. *David Siegel, Brian Arnold, and Martin G. Cohen, Stony Brook Univ., Stony Brook NY 11794.* Many atomic physics experiments use Ti: Sapphire lasers since they output a single frequency, are wavelength-tunable, and have good beam quality with a few watt output power. We designed and implemented a single-frequency Ti:Sapphire laser by self-injecting a retroreflected output beam. Supported by the Simons Foundation and ONR.

LM4G - 16 IPSII Shadow Simulations, *Carter F. Day, Jarom Jackson, and Dallin S. Durfee, Brigham Young Univ. Provo, UT 84602.* Using projected laser interference patterns, a new imaging method is being developed that circumvents conventional limitations. "Shadows" are cast in the patterns when imaging objects with a significant axial extent. Simulations are being run to determine the effects of these shadows on the resulting image. Preliminary tests will be discussed. Supported by Brigham Young Univ.

LM4G - 17 Ghost Imaging Techniques. *Jin Huh and Kiko Galvez, Colgate Univ., Hamilton, NY 13346.* Ghost imaging, or correlation imaging is a technique where an object is imaged by light that never interacts with it by utilizing the temporal and spatial correlation between entangled photons. We focus on the geometrical optics of correlated imaging for quantum entangled photons and its similarities to mirrored imaging.

LM4G - 18 Slow Light < 1000 m/s in Alkali Vapor in the Advanced Undergraduate Laboratory, *Linzhao Zhuo, Kenneth DeRose, Kefeng Jiang, Hong Cai, and Samir Bali, Miami Univ., Oxford, OH 45056.* Slow light in warm alkali vapor continues to be a research topic at the forefront of quantum information, and has therefore been extensively studied. However, an undergraduate-friendly experimental description does not exist. We endeavor to fill this gap, highlighting effects of potential pitfalls such as beam divergence and polarization impurity. Supported by ARO.

LM4G - 19 Probing and Accessing Electromagnetic Hotspots on Metallic Nano-Surfaces. *Sarah Thorud, Kallai Hokanson, and Nathan Lindquist, Bethel Univ., St. Paul, MN 55112.* Surface Enhanced Raman Spectroscopy relies on plasmon resonances or "hotspots" in a metal nanoparticle. Unfortunately, these hotspots often only cover a small area of the surface. We demonstrate that different hotspots are visible by varying the laser profile and polarization. Combining these signals creates high-resolution chemical images of the nanoparticle. Supported by NSF.

LM4G - 20 Symmetry in the Diffraction of Laguerre-Gauss Vortex Beams, *Emily Walla[1], Sophia Andaloro[2], Reeta Vyas[3] and Surendra Singh[3], 1) Univ. of Arizona, Tucson, AZ, 85721, 2) Univ. of Texas, Richardson, TX 75080 3) Physics Department, Univ. of Arkansas, Fayetteville, AR 72701*. Symmetry of the diffraction patterns of Laguerre-Gauss Vortex (LGV) beams by regular polygonal apertures and dependence on the orbital angular momentum (OAM) index of the LGV beam are studied. Experimentally recorded diffraction profiles exhibit symmetry and OAM index dependence consistent with the theoretical expectations. Supported by NSF.

LM4G - 21 Controlling Calcite Rhombohedrons in a Polarized Optical Trap. *Johanna R. Levey, and Catherine M. Herne, SUNY New Paltz, New Paltz, NY 12561*. Using an optical trap with an elliptically polarized beam, the non-uniform rotation displayed by rhombohedral calcite is investigated. This study improves the current model of rotational torque on calcite and allows for its better use in measurement and actuation applications. Calcite growth methods and rotational behavior are demonstrated and modeled. Supported by RSCA.

LM4G - 22 Further Testing the Theory Behind All-Optical QPM. *Eric Dyke, Amy L. Lytle, and Etienne Gagnon, Franklin and Marshall College, Lancaster, PA 17603.* We report an experiment designed to explore the effects of a form of phase matching called all-optical quasi phase matching using ultrafast laser pulses. We use a counterpropagating pulse interacting with a forward pulse through a nonlinear medium to analyze the second harmonic buildup of the forward counterpropagating beam. Supported by NSF.

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LM4G - 23 Using a Genetic Algorithm to Improve Selective Field Ionization and Study Dipole-Dipole Interactions Among Ultracold Rubidium Rydberg Atoms. *Maia Rabinowitz[1], Miao Wang[1], Lauren Yoast[2], Thomas J. Carroll[2], and Michael W. Noel[1], 1) Bryn Mawr College, Bryn Mawr, PA 19010 2) Ursinus College, Collegeville, PA 19426.* The time resolved signals from the 37p and 38s Rydberg states are almost completely overlapped when ionized with a ramped electric field. Using a genetic algorithm we optimize a perturbation to the ramp that separates the signals from these two states. This allows us to explore the 37p+37p→38s+37s dipole-dipole interaction. Supported by NSF.

LM4G - 24 Toward Locking a Ti:sapph Laser for use in Stimulated Raman Adiabatic Passage. *Willa Dworschack[1], Max Stanley[2], David Siegel[2], Xiaoyang Liu[2], and Harold Metcalf [2], 1) Lawrence Univ, Appleton, WI 54911 2) Stony Brook Univ., Stony Brook NY 11794.* The stimulated Raman adiabatic passage (STIRAP) process allows for an efficient population transfer between atomic states. The promotion of helium atoms to Rydberg states via STIRAP requires specific wavelengths from multiple frequency stabilized laser systems. We report our recent progress in implementing these methods. Supported by ONR and the Simons Foundation.

LM4G - 25 Plasmonic Nanotweezing and Nanoparticle Manipulation on a Silver Grid, *John J. McCauley, Joshua D. Kolbow, and Nathan C. Lindquist, Bethel Univ., St. Paul, MN 55112*. Surface plasmon "hotspots" were excited on a silver nano-grid and used to stably trap nanoparticles with a low intensity laser. Holographic illumination techniques were also developed to form a movable plasmonic hotspot within the grid. Simulations show that using such a grid with dynamic illumination would allow fine nanoparticle manipulation. Supported by NSF.

LM4G - 26 Observing a Violation of Bell's Inequality with Phase Randomized Weak Coherent Sources, *Quentin G. Anthony, Nurul T. Islam, and Daniel J. Gauthier, Ohio State Univ., Columbus, OH 43210.* We use phase randomized weak coherent states to simulate single photon sources. We use such a source to generate a polarization entangled state, which violates a Bell inequality. The theoretical description of the violation as well as data for a Bell's Inequality violation will be discussed. Supported by ONR.

LM4G - 27 Agile Phase Continuous RF Source for Ultracold Atom Applications, *J. D. Coffin, A. Rotunno, S. Du, and S. Aubin, College of William and Mary, Williamsburg, VA 23185.* A highly precise and phase continuous RF source has been developed and constructed for manipulating ultracold Rb and K atoms. The RF source is programmed over ethernet and is well suited for the multiple rapid triggered sweeps used in RF evaporative cooling and experiments on AC Zeeman forces. Supported by Virginia Micro-Electronics Consortium.

LM4G - 28 Hyperspectral Direct Imaging Using Compressive Sensing, *Alejandro Robles and Zhimin Shi, Univ. of South Florida Tampa, FL 33620.* We study the use of compressive sensing and direct measurement techniques to characterize an optical scene under multiple wavelengths of coherent illumination. Using the obtained phase information from multiple wavelengths, an absolute height map over a wide range can be obtained even with major phase discontinuities. Supported by ONR grant N00014-17-1-2443.

LM4G - 29 Numerical Modelling of Microwave Atom Chip Circuits, *I. Attanagoda, A. P. Rotunno, S. Du, and S. Aubin, Dept. of Physics, College of William and Mary, Williamsburg, VA 23185.* A coupled microstrip system and a coplanar waveguide to microstrip are modelled in the software FEKO to be used in a microwave atom chip capable of manipulating ultracold atoms with near fields. The application, modeling, and construction process are explained in this poster. Supported by William and Mary High Performance Computing Cluster.

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LM4G - 30 Dexterous Multifunctional Holographic Optical Traps, *Nina Wittler[1], Michael O'Brien[2], Argha Mondal[2], and David G. Grier[2], 1) Colgate Univ., Hamilton NY 13346, 2) New York Univ., New York, NY 10003.* Multiple multifunctional traps have been developed based on the theory of photokinetic effects. The traps are dexterous and have been created in the lab using holograms. The structuring fields of these traps exert forces on micro particles to make them perform various movements. Supported by NSF.

LM4G - 31 Implementing Quantum Pendulum With Light, *Enrique (Kiko) Galvez and Yingsi Qin, Colgate Univ., Hamilton, NY 13346.* We constructed two non-diffracting orbital angular momentum beams, Bessel and Mathieu Beams, and are making the Pendulum Beam. Our apparatus involves a MATLAB-programmed spatial light modulator and a series of optical setup. Supported by NSF.

LM4G - 32 Quantum Key Distribution Using Orbital Angular Momentum Modes. *MacKenzie Randle[1] and Robert Boyd[2], 1) Stevens Institute of Technology,Hoboken, NJ 07030 2) Univ. of Rochester, Rochester NY 14627.* Quantum key distribution can send secure keys between two parties. It uses N orbital angular momentum states sent as a series through a link. The desired message is a noiseless measurement of the received states. Travel-induced turbulence causes a background error rate, but. adaptive optics can partially compensate these errors. Supported by NSF.

LM4G - 33 Measuring bacterial attraction force with an optical trap. *Shanel Montreuil, Jing Lin, Christian Valentin, and Catherine Herne, SUNY New Paltz, New Paltz NY 12561.* Optical trapping offers a new measurement tool to learn about predatory Bdellovibrio bacteriovorus. We explore the attractive forces between B. bacteriovorus and Escherichia Coli by measuring the trap stiffness of B. bacteriovorus at various distances from the E. coli. We describe measurement techniques and preliminary results. Supported by RSCA**.**

LM4G - 34 Nonlinear Interference Pattern Observed in Quantum Dots, *Hamid Jalili, Thomas Danza, and Richard Mouradian, Adelphi University, Garden City, NY 11530.* In this research, nonlinear absorption of quantum dot samples was measured. Using the second harmonic of a nanosecond Nd:YAG laser an interference pattern was burned onto a quantum nanoparticle thin-film sample and reference sample and compared against linear and nonlinear absorption. Supported by Adelphi University.

LM4G - 35 Joint Uncertainty of Entangled Photons, *Zoya Shafique and Zeenat Baig, Adelphi Univ., Garden City, NY 11530.* We present our measurement of the position-momentum uncertainty of entangled photons generated though parametric down conversion. Unlike for single particles which follow Heisenberg's uncertainty principle, there is no lower limit for the joint uncertainty of entangled particles. We measured this uncertainty through the near - and far-field detection of entangled photons.

LM4G - 36 Measuring Thin Films Using a Mach-Zehnder Interferometer. *Matthew Stein, Erik Vaage, and Keith Stein. Bethel Univ., St Paul, MN 55112.* A soap bubble is placed in one arm of a Mach-Zehnder interferometer. Increased optical path lengths due to the soap film and the contained gas produce rings of constructive and destructive interference. The film thickness is quantified by measuring the radii of two destructive interference rings using a single-fringe background. Supported by Minnesota Space Grant Consortium.

Group Photo Break 3:55 – 4:00 PM - - - PLEASE assemble at the designated place !!!

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Session LM5G (oral): 4:00 - 4:45 PM, Ballroom East – Prof. Hong Lin, Bates College, Presider

LM5G - 1 Single Photon Sources Based on NV-center Nanodiamonds in Plasmonic Gold Bowtie Nanoantennas. *Jeremy C. Staffa[1], Svetlana G. Lukishova[1], and Andreas C. Liapis[2], 1) University of Rochester, Rochester, NY 14627, 2) Harvard Medical School, Boston, MA 02115.* Photon antibunching was observed from 20-nm NV-center nanodiamonds coupled to plasmonic gold bowtie nanoantennas, under 532-nm, CW excitation. Numerical modeling of bowtie nanoantennas included light scattering in different polarizations, Purcell factors for different dipole orientations and tunability of plasmonic resonances with isotropic/anisotropic refractive indices of the medium. Supported by NSF.

LM5G - 2 Development of a 776-nm Extended-Cavity Diode Laser for Low-Noise Detection of Laser-Cooled Rubidium Atoms. *M. T. Dufor[1], Elizabeth A. Donley[2], Kaitlin Moore[2], and James Mcgilligan[2], 1) West Virginia Univ., Morgantown, WV 26506, 2) N.I.S.T., Boulder, CO 80305.* Development is presented of a 776-nm extended cavity diode laser (ECDL) resonant with the $5P_{3/2}$-to-$5D_{5/2}$ transition in Rb, with the purpose of inducing blue light fluorescence from a Rb magneto-optic trap (MOT). Applications are described for atomic clocks and sensors in compact systems. Supported by NIST.

LM5G - 3 Modeling Frustrated Tunnel Ionization Experiments, *J. P. Ziegel[1], B. A. deHarak[1], R. D. Glover[2], D. Chetty[2], A. J. Palmer[2], I. V. Litvinyuk[2], and R. T. Sang[2], 1) Illinois Wesleyan Univ., Bloomington, IL 61701, 2) Centre for Quantum Dynamics, Griffith Univ., Brisbane, Australia.* In a strong laser field, electrons tunneling out of the potential well of a parent atom or molecule can return to a bound state in a process called frustrated tunnel ionization (FTI). Calculations of FTI yield for argon under various conditions will be discussed and compared to experimental results. Supported by the ARC Linkage Infrastructure, Equipment and Facilities scheme, NSF, and Australian Government RTP Scholarship**.**

LM5G - 4 Saturated Absorption Laser Spectroscopy on ^{40}Ar, *Giorgio A. Latour and John R. Brandenberger, Lawrence Univ., Appleton, WI 54911.* Saturated absorption laser spectroscopy has been used to measure the Landé gj-value ratios $g_j(2p6)/g_j(1s5)$ and $g_j(2p10)/g_j(1s5)$ for 40Ar. Then, by exploiting an existing and precise measurement for $g_j(1s5)$, we attain the values $g_j(2p6) = 1.30128(5)$ and $g_j(2p10) = 1.97436(22)$, representing 8- and 3-fold improvements in the precision of previous measurements. Supported by the Excellence in Science Fund of Lawrence Univ.

SPECIAL EVENT 4:45 - 5:10

Dr. Brad Conrad, National Director of the Society of Physics students, will speak about "Career pathways, choosing the right graduate program, and skills assessment".

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Session LM6G (oral): 5:15 – 6:00 PM, Ballroom East – Prof. Amy Lytle, Franklin and Marshall College, Presider

LM6G - 1 Observation and Analysis of Dicke Narrowing in an Optical Transition, *Kefeng Jiang, Ken DeRose, Linzhao Zhuo, Hong Cai, and Samir Bali, Miami Univ., Oxford, OH 45056.* We demonstrate Dicke-narrowed linewidths of few kHz in warm Rubidium vapor. The use of buffer gas causes the optical transition wavelength to exceed the collisional mean free path, suppressing Doppler broadening. The transition linewidth varies quadratically with relative pump-probe beam angle – a signature of Dicke-narrowing. We perform a detailed study. Supported by ARO.

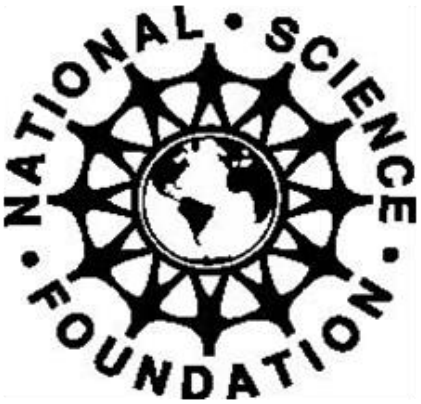
LM6G - 2 Ratchets in Cold Atom Dissipative Lattices, *Ajithamithra Dharmasiri, Alex Staron, Anthony Rapp, Patrick Janovick, and Samir Bali, Miami Univ., Oxford, OH 45056.* Natural biological machines significantly outperform artificially manufactured nanodevices by efficiently harnessing energy from random noise/fluctuations. Cold atom dissipative lattices are amenable for elucidating mechanisms to optimize efficiency in artificial nanomachines, with the goal of rivaling biomolecular motors. Our preliminary results demonstrating ratcheting in cold atoms will be discussed. Supported by ARO.

LM6G - 3 Wavelength Metrology with Webcams. *Jason N. Porter, Jonathan Treter, Jarom S. Jackson, and Dallin S. Durfee, Brigham Young Univ., Provo, UT 84602* We are developing a method of using data collected from a CCD camera to calculate the wavelength of a laser based on etaloning effects across the camera's Bayer array. Our proposed device is robust, inexpensive, and projected to yield picometer-level precision. Supported by the Brigham Young Univ.

LM6G - 4 Observing Transit Ramsey EIT Resonances in a Rb Vacuum Cell, *Ravn M. Jenkins, Eugeniy E. Mikhailov, and Irina Novikova, College of William and Mary, Williamsburg, VA 23185.* In a dual-channel arrangement for EIT in Rb vapor, we report the observation of a transient spectral feature due to the atoms traversing both beams while preserving their ground-state spin coherence. We demonstrate that the signal can be reduced or amplified by adjusting the path difference between the two beams. Supported by NSF.

Dinner at Rosemary's Thyme, 1801 18th St. 6:30

It's a short walk southeast from the Hilton - follow the group.



Symposium organized by Chad Hoyt and Harold Metcalf