SYMPOSIUM ON UNDERGRADUATE RESEARCH

Division of Laser Science of A.P.S - LS XXVI - 25 October 2010 - Rochester, NY

PARTICIPANTS' LUNCHEON - Highland B - 12:00

The participants' luncheon will bring together the Symposium students and distinguished laser scientists, including Alain Aspect, Margaret Murnane, Henry Kapteyn, and Joe Eberly.

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

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

POSTER SESSION - Riverside Court - 12:30

Session LSMA: 12:30 - 2:25 PM, Riverside Court – Grover Swartzlander, R.I.T., Presider

LSMA1 - **Polarization switching in a Multi-mode Vertical-cavity Surface-emitting Laser (VCSEL) Subject to Optical Injection,** *Amod J. Basnet and Hong Lin, Department of Physics and Astronomy, Bates College, Lewiston, ME 04240.* By applying orthogonal optical injection to a VCSEL, we achieved frequency locking and polarization switching (PS) in single and multiple transverse mode domains. We examined the effect of single and two-frequency injection. Instability due to gain competition was observed near the boundary of the PS regime. Supported by Bates College.

LSMA2 - **Dynamic Diffraction Analysis *C. elegans,*** *Alicia Sampson, Rebecca Eells, Kate Susman, and Jenny Magnes, Vassar College, Poughkeepsie, NY 12604.* We correlate changes in diffraction patterns with locomotion of *C. elegans* in three dimensions. Three-dimensional navigation has hardly been explored since studies are tied to two-dimensional focal planes under microscopes. We examine behavioral patterns of *C. elegans* under different constraints using a diffraction system that is not dependent on focal planes. Supported by URSI.

LSMA3 - **Search for Collisional Exchange of Ground-State Atomic Alignment Between Rubidium and Cesium Atoms,** *Srikanth Guttikonda[1], Eric J. Bahr[1], Oliver Neitzke[2], D. F. Jackson Kimball[1], and D. Budker[2], 1) California State University - East Bay, Hayward, CA 94542. 2) University of California at Berkeley, Berkeley, CA 94720.* We report on a search for collisional transfer of ground-state atomic alignment between rubidium and cesium atoms. Alignment-exchange cross sections are suppressed relative to spin-exchange cross sections by four orders of magnitude. The results have implications for tests of fundamental physics. Supported by NSF and ONR.

LSMA4 - **Study of the Systematic Effects in the Search for Variation of the Fine-Structure Constant,** *Uttam Paudel, Nathan Leefer, and Dmitry Budker, University of California, Berkeley, CA 94720.* We are searching for the variation of the fine-structure constant in atomic dysprosium using frequency modulated rf-spectroscopy. To measure transition frequencies with a high precision, we developed a protocol to stabilize residual amplitude modulation, which reduces the apparent shifts of the transition frequencies. Supported by DOE.

LSMA5 - **Exploring the Feasibility of a Permanent Magnet Zeeman Slower for Sodium**, *Jennifer L. Hansen[1], Patrick Zabawa[2], Amy Wakim[2], Nicholas P. Bigelow[2], S.P. Krzyzewski[3], T.G. Akin[3], P. Dahal[3], and E.R.I. Abraham[3], 1) Grove City College, Grove City, PA 16127, 2) University of Rochester, Rochester NY, 14627, 3) University of Oklahoma, Norman, OK 73069.* Traditional Zeeman slowers create magnetic fields by passing current through coils. Using permanent magnets would require no power or maintenance. Using a *Mathematica* program developed at OU, the possibility of a permanent magnet Zeeman slower for sodium was investigated. Cost, difficulty to machine, and magnetization were all taken into account. Supported by NSF.

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LSMA6 – **Diffraction of Optical Vortex Beams,** *Michael Lucini[1], H. Shiau[2], Reeta Vyas[2], and Surendra Singh[2], 1) Physics, Boston College, Chestnut Hill, MA 02467, 2) Physics, University of Arkansas, Fayetteville, AR 72701.* Diffraction of optical Laguerre-Gauss vortex beams by simple apertures is studied experimentally. Experimentally recorded diffraction intensity profiles reveal several novel features, which are in good agreement with theoretically computed intensity profiles. Supported by NSF.

LSMA7 – **Low-Noise Piezoelectric Driver for External Cavity Diode Lasers**, *Michael C. Hermansen, James L. Archibald, Chistopher J. Erickson, and Dallin S. Durfee, Brigham Young University. Provo, UT 84602.* We developed a low-noise, high-voltage amplifier to operate piezoelectric actuators for external cavity diode lasers. Our goal is to obtain lower-noise levels compared to commercial amplifiers. The design uses low-cost components allowing for the inexpensive construction of multiple channels. Supported by NSF and NIST.

LSMA8 – **Scattering of Poly Latex Microspheres,** *Rebecca Eells, Noureddine Melikechi, Yuri Markushin, and Jenny Magnes, Vassar College, Poughkeepsie, NY 12604.* The goal was to develop a technique for determining the size, shape, and concentration of biological particles using light scattering. Predictions were made using a Rayleigh-Debye equation for scattered light. Supported by URSI.

LSMA9 - **Bessel-Gauss Beams With Radial and Azimuthal Polarization,** *William Lewis, Reeta Vyas, and Surendra Singh, Department of Physics, University of Arkansas, Fayetteville, AR 72701.* Bessel-Gauss beams are solutions of Maxwell's equation in cylindrical coordinates with Gaussian localization in the paraxial approximation. We construct higher order correction terms to the radial, azimuthal, and longitudinal polarizations and study the effects of beam propagation.

LSMA10 - **Using Thermally Poled Duran Glass as a Substrate for Creating Self-Assembled Monolayers,** *Taylor Shoulders[1] and Marc Dussauze[2], 1) Clemson University, Clemson, SC 29634, 2) University Bordeaux 1, Bordeaux, France.* The induced non-linear optical properties and structural changes in thermally poled Duran glass have been characterized. An attempt was made to construct a self-assembled mono-layer of octadecyltrichlorosilane on the surface of the glass. Supported by NSF.

LSMA11 - **Design and Implementation of a Timing Control System for Use in a Bose-Einstein Condensate (BEC) Experiment,** *Daniel N. Gresh and 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 hardware interface and timing algorithms with microsecond precision on up to 100 digital and analog channels. Supported by NSF and ARO.

LSMA12 - **Construction of a Sr+ Interferometer for Precision Measurement of Electric and Magnetic Fields,** *Benjamin L. Francis[1], Christopher J. Erickson[2], and Dallin S. Durfee[2], 1) Brigham Young University-Idaho, Rexburg, ID* 83460 *2) Brigham Young University, Provo, UT 84602.* We are currently assembling the electronics and optical systems for the interferometer. An overview of interferometer operation will be presented. Our components include a magneto-optical trap for creating a slow ion source, magnetic coils for creating a quantization axis, and an acousto-optic modulator for frequency shifting the cooling laser. Supported by NSF.

LSMA13 - **Characterization of Retardance of Wave Plates**, *Steven Keith[1], Dash Vitullo[2], and Michael Raymer[2], 1) Henderson State University, Arkadelphia, AR 71999, 2) University of Oregon, Eugene, OR 97403.* An instrument was developed for characterizing the retardance of wave plates. The deviation from the ideal quarter-wave or half-wave retardance of commercial wave plates was determined. This is necessary information when utilizing wave plates in a polarimeter, which is used for characterizing polarization of modes propagating in an optical fiber. Supported by NSF and Oregon Center for Optics.

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LSMA14 - **Detection of an Object in a Noisy Background**, *Karen L. Martuscello, Malcolm N. O'Sullivan, and Robert W. Boyd, University of Rochester, Rochester, NY 14627.* We examine the quality of thermal ghost images obtained in the presence of a noisy background. We investigate the minimum time needed to determine the presence or absence of a target for different noise levels. We find that ghost imaging can detect the presence or absence of an object. Supported by the Xerox Undergraduate Research Fellows Program.

LSMA15 - **Raman Pump-Probe Spectroscopy in Cold Rubidium Atoms**, *Jeffrey Kleykamp, Andrew Hatchel, Don Kane, and Samir Bali, Miami University, Oxford, OH 45056.* We have measured light shifts as a function of intensity in cold rubidium atoms using Raman pump-probe spectroscopy. We present our ongoing experiments on Raman Zeeman resonances in cold atoms. Supported by Miami University and Petroleum Research Fund.

LSMA16 - **Characterization of Pollen Particles Using LIDAR.** *Leda Sox[1], Gary Gimmestad[2], Allison Mercer[2], and Amy Sullivan[1], 1) Agnes Scott College, Decatur, GA 30030, 2) Georgia Tech Research Institute, Atlanta, GA 30332.* We have observed pollen in the local troposphere using the depolarization capabilities of a LIDAR (Light Detection and Ranging) system. The polarization characteristics of the received LIDAR signal, along with supplemental pollen forecast data, allowed me to characterize the shape of the pollen particles. Supported by NSF.

LSMA17 - **Active Magnetic Stabilization for Atomic Magnetometer Sensitivity Measurements,** *Christopher J. Axline[1,2], Rahul R. Mhaskar[2], Svenja A. Knappe[2], and John Kitching[2], 1) University of California Santa Barbara, Santa Barbara, CA 93106, 2) National Institute of Standards and Technology, Boulder, CO 80305.* High-performance atomic magnetometers require calm magnetic environments for testing and characterization. To provide such an environment, we characterized magnetic noise in a laboratory and compensated for it using an active, three-axis cancellation system. Cross-axial feedback coupling and system performance were assessed. Supported by NSF, NIST, DARPA.

LSMA18 - **Designing an Optical Dipole Trap for the Creation of Bose-Einstein Condensates,** *Amy Van Newkirk[1], L. S. Leslie[2], A. Hansen[2], and N. P. Bigelow[2], 1) Grove City College, Grove City, PA 16127, 2) University of Rochester, Rochester, NY 14627.* We are currently designing a red-detuned, single focused-beam dipole trap to produce Bose-Einstein condensates because pure dipole traps have the possibility of spin-state independence. We developed a *Mathematica* model that indicates that our current lab configuration has the possibility of producing a dipole trap that will allow for Bose-Einstein condensation. Supported by NSF.

LSMA19 - **Azobenzene Functionalized SAM Isomerization Probed by Vibrational Sum Frequency Generation Spectroscopy,** *Matthew Onstott[1], David Valley[2], and Alexander V. Benderskii[2], 1) Wichita State University, Wichita, KS 67260, 2) University of Southern California, Los Angeles, CA 90095.* Surface bound azobenzene has potential applications in photoswitchable optical media, molecular electronics, and smart wetting surfaces. SFG spectroscopy provides a surface-selective method for studying the vibrational modes of surface molecules, as well as molecular orientation. We are presenting synthesis of azobenzene functionalized monolayer on gold substrates along with SFG characterization. Supported by NSF.

LSMA20 - **Vector Magnetometer with Rb Vapor,** *Kevin Cox, Irina Novikova, and Eugeny Mikhailov, College of William and Mary, Williamsburg, VA 23187.* This project demonstrates an optical method for measuring magnetic fields using electromagnetically induced transparency (EIT) in rubidium vapor. Both magnitude and direction are deduced by scanning multiple Zeeman shifted EIT resonances. High precision and the possibility of multi-dimensional field mapping make this a powerful technique for magnetic field imaging applications. Supported by the Jeffress Research Fund, NSF, and Virginia Space Grant Consortium.

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LSMA21 - **Real-Time Experimental Visualization of Vortex Dynamics in Stirred Bose Einstein Condensates,** *Emine Altuntas, Thomas K. Langin, Aftaab Dewan, and David Hall, Amherst College, Amherst, MA 01002.* We stir a Bose Einstein Condensate of ^{87}Rb using a laser beam and nucleate vortices in an oblate geometry. Using our novel imaging technique, which generates a sequence of images of vortex lines in the same trapped condensate, we have studied the dynamics of single and co-rotating vortices. Supported by NSF.

LSMA22 - **Using LIDAR to Observe Atmospheric Conditions Before and After Rainstorms**, *Haviland Forrister[1], Leda Sox[1], Amy Sullivan[1], and Lauren Guerrido[2], 1) Agnes Scott College, Decatur, GA 30030, 2) Spelman College, Atlanta, GA 30314.* A pulsed 532 nm atmospheric LIDAR assembly is used to observe clouds and aerosols above the Agnes Scott Observatory. Several data of pre- and post-rainstorm conditions were taken. A distinct correlation was recognized between several clouds being in close vertical proximity and actual rainfall. Supported by NSF and Agnes Scott College.

LSMA23 - **Strong-field Induced Coulomb Explosion Simulation.** *Benjamin Crist, Guan-Yeu Chen, and W. T. Hill III, Dept. Physics, JQI and IPST, University of Maryland, College Park, MD 20740.* Optimal closed-loop control combined with Coulomb explosion imaging is a powerful technique for probing strong-field dynamics. Fitting a mathematical model to the experimental images allows the molecular dynamics to be extracted. This approach is used to measure CO2 changes as a function of pulse parameters. Supported by NSF.

LSMA24 - **Laser Induced Ag Nano-Clusters in Glass,** *Amanda Webb, Jiyeon Choi, Mark Ramme, and Martin Richardson, Townes Laser Institute, University of Central Florida, Orlando, FL 32816.* Ultrashort lasers pulses are used to irradiate glass causing the formation of Ag nanoparticles. It is believed that using a higher laser repetition rate will create a higher cluster density of the Ag micro-clusters formed. When optically pumped, these silver micro-clusters are assumed to produce a second harmonic generation. Supported by NSF.

LSMA25 - **Fourier Transform Infrared** Spectr**oscopy,** *Danielle Simmons[1], Nathan Bodnar[2], Matthieu Baudelet[2], and Martin Richardson[2], 1) University of North Carolina at Chapel Hill, Chapel Hill, NC 27514, 2) Laser Plasma Laboratory, Townes Laser Institute, University of Central Florida, Orlando, FL 32816.* Experiments pertaining to the characterization of a Fourier Transform infrared spectrometer built by Oriel for the purpose of incorporation in a Laser Ignition Facility. An algorithm was created to reconstruct an interferogram interrupted by a pulsed signal. Supported by NSF and ARO.

LSMA26 - **Creating Arbitrary Optical Potentials in Free Space via Phase-Contrast Imaging,** *Brian McIlvain, Jeffrey Lee, and W. T. Hill III, Dept. of Physics, JQI and IPST, University of Maryland, College Park, MD 20740.* We used phase-contrast imaging to make prototype free-space "atom chips" suitable for "atomtronics." Analysis shows this all-optical approach to be efficient, creating confining potentials (from blue and/or red light) that are modifiable in real time and contain abrupt corners. Supported by NSF, PFC, and NSA.

LSMA27 – **Generation of Optical Vector Beams,** *Hunter Schubert and Enrique Galvez, Colgate University, Hamilton, NY 13346.* We investigate the generation of vector beams, pure modes of light with a spatial polarization modulation, for use in producing entangled states of modes. In our research we developed an interferometric method of generating these beams using a spatial light modulator and a polarization beam displacer.

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LSMA28 - **Iridescence of Beetles,** *Alexandra Bello, Varada Iruvanti, Robert Suter, Chandran Sabanayagam, and Jenny Magnes, Vassar College, Poughkeepsie, NY 12604.* Beetle shells change color as the angle of incident light changes. This effect was studied by taking reflectance spectra of the shells. Supported by Vassar URSI program and CAOSS of Delaware State Univ.

LSMA29 - **Ocean Water Column and Benthic-Boundary Probing Using LIDAR,** *S. Meijer and T. Bensky, California Polytech Univ., San Luis Obispo, CA 93407.* We have constructed a LIDAR station that fires a Nd:YAG laser directly into ocean water. A PMT placed near the laser aperture feeds a picosecond time analyzer that histograms the return times of photons. Photon return events are observed to generate unique return spectra from localized back-scattering events.

LSMA30 - **A Dual-pumping Geometry for Non-collinear Optical Parametric Amplification,** *Nathan Bodnar[1], Julien Nillon[2], Eric Cormier[2], and Martin Richardson[1], 1) University of Central Florida, Orlando, FL 32816, 2) University of Bordeaux 1, France.* We studied non-collinear optical parametric amplification (NOPA) involving a symmetrical dual-pumping geometry. Compared to conventional pumping schemes, higher gain as well as broader spectral amplification can be achieved. Further studies based on this report are ongoing to implement higher levels of amplification while reducing the number of OPA stages. Supported by NSF.

LSMA31 - **Refractive Index Profiling using Transport-of-Intensity Equation and Abel Inversion,** *Chris Nergard, Mark Ramme, and Martin Richardson, University of Central Florida, Orlando, FL 32816.* Three intensity images of a modification in transparent material at varying focal depths allow an optical phase shift map to be calculated by solving the transport-of-intensity equation. The refractive index profile over that modification is obtained from an Abel inversion taking in the phase shift map among other physical measurements. Supported by NSF.

LSMA32 - **Creating an Electrically Switchable Diffraction Grating in a Liquid Crystal Cell,** *Ekaterina Sergan [1], Tatiana Sergan[2], Vassili Sergan[2], Harold Metcalf [3], and John Noe [3], 1) University of California at Davis, Davis, CA 95616, 2) California State University, Sacramento, Sacramento, CA 95819, 3) Laser Teaching Center, Stony Brook University, Stony Brook, NY 11794.* A 1.0 mm period phase diffraction grating was created within an LC cell containing <1% photopolymer by exposing the cell to UV light through a mask while applying 120 VAC. Diffraction of HeNe laser light was affected by incident polarization and applied voltage, and the grating turned off above 60 Vpp. Supported by NSF.

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

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Session LSMB: 2:30 - 4:15 PM, Highland B - Hong Lin, Bates College, Presider

LSMB1 - **Sensitivity Optimization of a Dual Isotope Rubidium Magnetometer,** *Ian Lacey, Delyana Delcheva, L. R. Jacome, Rodrigo Peregrina, Julian Valdez, and D. F. Jackson Kimball, Cal. State Univ. East Bay, Hayward, CA 94542.* We report progress on optimization of a dual-isotope Rb magnetometer to be used in experiments searching for anomalous spin-dependent interactions of the proton with the earth's gravitational field. Supported by NSF.

LSMB2 - **Focusing an Optical Vortex Beam With Residual Astigmatism,** *Hannarae Annie Nam[1], Martin G. Cohen[2], and John Noé [2], 1) Choate Rosemary Hall, Wallingford, CT 06492, 2) Laser Teaching Center, Stony Brook University, Stony Brook, NY 11794.* We investigated focusing an astigmatic optical vortex beam created with a single cylinder lens. The vortex reverts to the original HG(1,0) mode at the center of the focal region, but this undesirable effect can be eliminated by suitably tilting the focusing lens. Beam parameter calculations support our observations. Supported by the Simons Foundation and the Laser Teaching Center.

LSMB3 - **Using Laser Induced Breakdown as a Probe to Measure Pressure,** *Evan Baker, Nicholas Goble, Daniel LaRocca, and Bruno deHarak, Illinois Wesleyan University, Bloomington, IL 61701.* We will present two methods that use laser induced breakdown to measure pressure. These techniques require no physical probe, have a spatial resolution of ~ 1 mm, and can make measurements at nanosecond timescales. We will provide a detailed description of these techniques, and show preliminary data obtained with these methods. Supported by an ASD grant from IWU.

LSMB4 - **Consequences of the Use of Slow Detectors on the Performance of Thermal Ghost Imaging,** *Molly Krogstad[1], Malcolm O'Sullivan[2], and Robert Boyd[2], 1) University of Minnesota, Minneapolis, MN 55455, 2) University of Rochester, Rochester, NY 14627.* We studied the influence of slow detectors on the contrast-to-noise ratio (CNR) of a thermal ghost image. We found that the image quality was not degraded by a detector so slow that many speckle patterns were averaged together. Supported by NSF.

LSMB5 - **Optical Diffraction Tomography for Characterization of Waveguides in Photopolymer,** *Mary L. Hinkle, Ethan Sudan, Amy C. Sullivan, Agnes Scott College, Decatur, GA 30030.* We present a tomographic method for characterizing waveguides embedded in a photopolymer. Intensity measurements of diffraction maxima are used to image micron-scale waveguides without the use of lenses. Supported by the Henry Luce Foundation.

LSMB6 - **Real-Time Dynamics of Single Vortex Lines and Vortex Dipoles in a Bose-Einstein Condensate,** *Thomas K. Langin, Daniel V. Freilich, Adam M. Kaufman, Dylan M. Bianchi, and David S. Hall, Amherst College, Amherst, MA 01002.* We study real-time dynamics of quantized vortices in trapped dilute Bose-Einstein Condensates. The precession frequency of a single vortex is measured by repeatedly imaging a condensate, and is found to be in good agreement with theory. We also present initial studies of the dynamics of vortices in counter-rotating (dipole) configurations. Supported by NSF and Amherst College Schupf Scholars Program.

LSMB7 - **Creating Unconventionally-Polarized Beams by Stress-Induced Birefringence,** *Jacob Chamoun[1], Martin G. Cohen[2], and John Noé [2], 1) Cornell University, Ithaca, NY 14853, 2) Laser Teaching Center, Stony Brook University, Stony Brook, NY 11794.* Following T. Brown and A. K. Spilman [Appl. Opt. 2007], we created a wave plate with a spatially-varying fast-axis orientation by applying stresses to a plexiglass disk. Images of transmitted intensity taken with appropriate polarizer-analyzer combinations were analayzed in MATLAB to create transverse polarization maps. Supported by NSF.

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Session LSMC: 4:30 – 6:00 PM, Highland B – Amy Sullivan, Agnes Scott College, Presider

LSMC1 - **Measurement of the Complex Refractive Index of Highly Turbid Media**, *Bradley Worth II, Sarabjot Makkar, Maio Dong, Lalit Bali, and Samir Bali, Miami University, Oxford, OH 45056*. We demonstrate a first simultaneous measurement of the real and imaginary parts of the refractive index of a highly turbid aqueous suspension of polystyrene microspheres. We find that the reflectance data are well described by Fresnel theory that correctly includes the effect on total internal reflection of angle-dependent penetration into the turbid medium. Supported by Petroleum Research Fund and Miami University.

LSMC2 - **Observing the Pancharatnam-Berry Phase on the Poincaré Sphere,** *Heather Hill[1], Martin G. Cohen[2], and John Noé[2], 1) Duke University, Durham, NC 27708, 2) Laser Teaching Center, Stony Brook University, Stony Brook, NY 11794.* A beam of monochromatic light that undergoes a cyclic change of polarization state gains a topological phase, the Pancharatnam-Berry phase. Following van Dijk et al. [Proc. SPIE 7613, 2010] a Mach-Zehnder interferometer was used to observe the dependence of this small effect on the path traversed on the Poincaré sphere. Supported by NSF.

LSMC3 - **Preparing and Projecting Vector Beams for Use with Single Photons,** *Sean Nomoto[1] and Enrique J. Galvez[2], 1) University of Wisconsin – River Falls, River Falls, WI 54022, 2) Colgate University, Hamilton, NY 13346.* A polarization interferometer splits polarizations states of a Helium-Neon laser encoding Hermite-Gauss modes HG10 and HG01 in each arm using tilted coverslips. Confirmed Vector beams by polarization and mode analysis. Laguerre-Gauss modes were projected onto Hermite-Gauss beams and investigated with coverslips and single-mode fibers. Supported by Colgate Physics and Astronomy and McNair Scholars Program, University of Wisconsin - River Falls.

LSMC4 - **Observation of Elliptical Rings in Spontaneous Parametric Down Conversion,** *Yu-Po Wong, Hannah Guilbert, and Daniel J. Gauthier, Duke University, Durham, NC 27705.* The nonlinear optical process of spontaneous parametric down conversion is widely used to produce highly efficient entangled quantum states of light. It is believed that the photon pairs are generated in a ring surrounding the pump laser beam. A CCD camera measures the shape of the pattern and shows that it is elliptical. Supported by DARPA and the Duke University Department of Physics.

LSMC5 - **Resonant Energy Exchange Among Cold Rydberg Atoms,** *Emily E. Altiere[1], Rachel Smith[2], Thomas J. Carroll[2], and Michael W. Noel[1], 1) Bryn Mawr College, Bryn Mawr, PA 19010 2) Ursinus College, Collegeville, PA 19426.* Cold Rydberg atoms exchange energy through dipole-dipole interactions. The Stark effect allows us to vary the electric field bringing into resonance this energy exchange. We present spectra of two-body resonant energy exchanges for a range of initially excited Rydberg states, as well as a possible three-body interaction. Supported by NSF.

LSMC6 - **Imaging Single Nitrogen Vacancy Centers in Diamond,** *Kyle Weigand[1], Hailin Wang[2], David A. Golter[2], 1) Augustana College, Rock Island, IL 61201, 2) University of Oregon, Eugene, OR 97403.* Our project was aimed toward measuring and manipulating electron and nuclear spins associated with the NV center in diamond. We engineered a confocal laser-scanning microscope, and obtained images of a diamond sample showing the optically excitable defects. Supported by NSF and ARO.

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