XXXVII

Annual

Rochester Symposium for Physics (Astronomy & Optics) Students SPS Zone 2 Regional Meeting

April 7, 2018

Department of Physics & Astronomy
University of Rochester
Rochester, NY 14627-0171

The College at Brockport
350 New Campus Drive
Brockport, NY 14420

Cosponsored by:
National Office of the Society of Physics Students; Department of Physics and Astronomy, University of Rochester; Physics Department, The College at Brockport; Department of Energy; National Science Foundation (REU Program)

The College at Brockport, April 7, 2018

Dear Participants:

Welcome to the 37th annual Rochester Symposium for Physics Students (RSPS). The RSPS was instituted to provide an opportunity for undergraduates to present an account of their own personal research at a meeting whose format was chosen to closely resemble those of professional scientific societies.

At these symposia, research projects are presented in talks or poster sessions by undergraduates representing many regional institutions. Topics include condensed-matter physics, atomic physics and optics, computational physics, astronomy, particle and nuclear physics, instrumentation and techniques, environmental physics, biological physics, medical physics, and educational physics. The abstracts of all the participants' papers are published annually in the RSPS proceedings and distributed to the participants. The information is also available on line at: http://www.pas.rochester.edu/news-events/rsps/2018/index.html

Students who present these talks can list their RSPS presentation(s) on their resumes and show the above web page in their list of publications as an "On-line Published Abstract". We encourage students to follow up on their research with the aim of giving a presentation at a regular American Physical Society (APS) meeting (which now also has a special session on undergraduate research), and eventually follow up with a publication in a regular journal, or in the APS Journal of Undergraduate Research.

At Rochester, the Department of Physics and Astronomy and the Institute of Optics are jointly running two National Science Foundation (NSF) funded Research Experience for Undergraduates (REU) sites. We encourage you to apply to one of these summer programs. Examples of research projects, talks, publications and awards won by our REU participants can be found on our REU Web page: https://www.pas.rochester.edu/undergraduate/reu/index.html

Your audience will include both students and faculty members and will provide you with the opportunity to address a knowledgeable and appreciative assembly of fellow researchers. Scientific research is an extraordinary activity. We certainly hope that many of you will decide to pursue careers that involve you intimately in mankind's greatest intellectual adventure, to comprehend nature. To quote Albert Einstein, “The eternal mystery of the world is its comprehensibility.”

Frank Wolfs (Chair RSPS)
Department of Physics and Astronomy
University of Rochester

LIST OF SPEAKERS

NAME	TIME	ROOM
Cristian Almodovar	11:00	Edwards 101
Jonathan Ballard	9:30	Edwards 101
Yuxuan Cao	10:30	Edwards 102
Lisa Chan	10:30	Edwards 102
Micah Coats	11:30	Edwards 103
Micah Coats	10:30	Edwards 102
Jolene Cobb	10:15	Edwards 101
Natasha Collova	9:00	Edwards 103
Anthony D'Addario	9:00	Edwards 101
Sean Dempsey-Gregory	10:30	Edwards 102
Daniel Eager	1:45	Edwards 103
Patrick Flood	12:00	Edwards 101
Torri Halaquist	2:15	Edwards 103
Jeremy Hartse	10:30	Edwards 102
Josh Hayes	2:30	Edwards 103
Kassidy Howard	10:30	Edwards 102
Matthew Johnson	1:30	Edwards 101
Jafr Kazmi	1:45	Edwards 101
Ouail Kitouni	12:00	Edwards 103
Timothy Ladeairous	11:30	Edwards 101
Natalie Macdonald	10:30	Edwards 102
Jeremy Martin	1:30	Edwards 103
Morgan McCarthy	10:15	Edwards 103
Brett Meerdink	9:45	Edwards 103
Luke Milbocker	9:45	Edwards 101
Noor Muzammal	11:45	Edwards 103
Scott Nieboer	2:00	Edwards 101
Stephen Paolini	9:15	Edwards 101
Heather Phillips	2:30	Edwards 101
Heather Phillips	10:30	Edwards 102
Erik Pohl	2:15	Edwards 101
Yufan Qie	12:15	Edwards 103
Clare Reilly	11:15	Edwards 101
Dylan Richmond	9:15	Edwards 103
Dylan Richmond	10:30	Edwards 102
Mayuka Sasaki	10:00	Edwards 101
Derek Sherry	11:15	Edwards 103
Nolan Smyth	11:00	Edwards 103

NAME	TIME	ROOM
Matthew Sodano	9:45	Edwards 103
Benjamin Swanson	10:30	Edwards 102
Pouya Tanouri	10:00	Edwards 103
Brandon Watt	11:45	Edwards 101
Jake Weeks	2:00	Edwards 103
Chris Wells	9:30	Edwards 103

XXXVII – ROCHESTER SYMPOSIUM FOR PHYSICS (ASTRONOMY AND OPTICS) STUDENTS
SPS ZONE 2 REGIONAL MEETING

PROGRAM

8:00 AM – 8:45 AM: REGISTRATION AND POSTER SETUP (EDWARDS HALL)

8:45 AM: WELCOME: PROF. ERIC MONIER (SUNY BROCKPORT) AND PROF. FRANK WOLFS, UNIVERSITY OF ROCHESTER (EDWARDS 103)

9.00 AM – 10:30 AM: SESSION IA. ASTRONOMY & ASTROPHYSICS (EDWARDS 103)

SESSION CHAIR: PROF. SHASHI KANBUR, SUNY OSWEGO

9:00 **Probing Gas Stripping with Resolved Star-Formation Maps of Virgo Filament Galaxies**
Natasha Collova, Siena College

9:15 **The Use of Different Isochrones with UniDAM**
D Richmond, A. Mints, S. Hekker, S. Kanbur, SUNY Oswego; Max Planck Institute for Solar System Research, Gottingen

9:30 **Clustering Fundamental Mode RR Lyrae in Relation to the Oosterhoff Dichotomy**
C. Wells, S. Kanbur, A. Bhardwaj, SUNY Oswego; University of Delhi

9:45 **A Study of the Periods of Variable Stars in the OGLE Catalogue**
B. Meerdink, M. Sodano, S. Kanbur, SUNY Oswego; University of Delhi

10:00 **IceCube Neutrino Observatory**
Pouya Tanouri, University of Rochester

10:15 **Characterizing the Dark Matter Profile of the Triangulum II Galaxy**
Morgan McCarthy, University of Rochester

9:00 AM – 10:30 AM: SESSION IB. CONDENSED MATTER & BIOLOGICAL PHYSICS (EDWARDS 101)

SESSION CHAIR: PROF. MARK YULY, HOUGHTON COLLEGE

9:00 **Computational Model of Neural Synapse Characteristics Using Josephson Junctions**
Anthony D'Addario, Colgate University

9:15 **Nonlinear Dynamics of Vortex-Breather Collisions**
Stephen Paolini, Colgate University

9:30 **SEM Analysis of NiTi Welds and Properties, Including Design of Strain Stage for In-situ Measurements**
Jonathan Ballard, Houghton College

9:45 **Optical Properties of Van der Waals Materials**
Luke Milbocker, Rensselaer Polytechnic Institute

10:00 **Synthesis of Two-Dimensional Materials**
Mayuka Sasaki, The College at Brockport, Department of Physics

10:15 **Investigating the Incorporation of Antimicrobial Elements into 3D Printed Products**
Jolene Cobb, Siena College

10:30AM – 11:00 AM: SESSION II. POSTER SESSION (EDWARDS HALL)

Inkjet Printed Nanocrystalline Inorganic Perovskite Films: the Novel Solar Cells
Benjamin Swanson, Ian Evans, Andrew Yost, F. Guzman, M. Shekhirev, J. Teeter, N. Benker, S. Sikich, A. Enders, P. Dowben, A Sinitskii, Carolina C. Ilie; Department of Physics, SUNY Oswego; Department Physics and Astronomy, University of Nebraska-Lincoln; Department of Physics, California State University-San Bernardino; Department of Chemistry, University of Nebraska-Lincoln; Department of Chemistry, Doane College, Crete, NE; Physikalisches Institut, Universität Bayreuth, Bayreuth, Germany

Simulating Impeller Mixing Under Various Conditions
Heather Phillips and Jonathan Durbin, Houghton College

A Phoswich Detector System to Measure Sub-Second Half-Lives using ICF Reactions
Katelyn Cook, Micah Coats, Mark Yuly, Stephen Padalino, Craig Sangster, Sean Regan, Houghton College, SUNY Geneseo, Laboratory for Laser Energetics

Cavity Optics for Frequency-Dependent Light Squeezing
Natalie Macdonald, Laboratoire Kastler Brossel, National Science Foundation

Research of Protostellar Outflows
Kassidy J Howard, SUNY Fredonia

Analysis of Dark Frames and the Consistency of Flat Field Frames
Sean Dempsey-Gregory, SUNY Fredonia

Study of Capillary Condensation for Different Geometries: Biophysical Applications
Dylan Richmond, Ian Evans, Ildar Sabirianov, Julia D'Rozario, Marie T. Romano, and Carolina C. Ilie, SUNY Oswego

An interactive visual interface for the determination of similarity patterns in the Fourier spatial frequency spectrum of laser speckle
Sam Payne; Lisa Chan; Wei Cheng Lin; Stewart Russell, The City College of New York; SUNY Binghamton; Dartmouth College

Warm Dense Matter Stopping Power Experiment and Analysis with OMEGA
Yuxuan Cao, University of Rochester

Neutron and Proton Emission in Models of Nearly Elastic Neutrino-Nucleus Interactions
Jeremy Hartse, University of Rochester

11:00 AM – 12:30 PM: SESSION IIIA. NUCLEAR AND PARTICLE PHYSICS & ASTRONOMY AND ASTROPHYSICS (EDWARDS 103)

SESSION CHAIR: PROF. BRANDON HOFFMAN, HOUGHTON COLLEGE

11:00 **Fuzzy Cold Dark Matter**
Nolan Smyth, Colgate University

11:15 **Partially Interacting Dark Matter, Dark Disks, and Dark Plasma**
Derek Sherry, Colgate University

11:30 **Measurement of the Transverse Doppler Shift using the Mossbauer Effect**
Micah Coats, Houghton College

11:45 **Can Stars Exist Without Rotating?**
Noor Muzammal, S. Sahijpal, Volker Maiwald, M.I.T, German Aerospace Center (DLR)

12:00 **Search for Type Ia supernovae and other transients in SDSS**
Ouail Kitouni, Ryan Rubenzahl, University of Rochester

12:15 **Calculating the rotation curve due to visible matter in the Milky Way Galaxy**
Yufan Qie, University of Rochester

11:00 AM – 12:30 PM: SESSION IIIB. INSTRUMENTATION/EXPERIMENTAL TECHNIQUES (EDWARDS 101)

SESSION CHAIR: PROF. CANDICE FAZAR, ROBERTS WESLEYAN COLLEGE

11:00 **Radio JOVE**
Cristian Almodovar, Siena College

11:15 **The Gravity Battery**
Clare Reilly , Siena College

11:30 **3D Object Scanner**
Timothy Ladeairous, Jon Farrel, Siena College

11:45 **Wild Life Trail Camera vs. Raspberry Pi Camera**
Brandon Watt, Dr. McColgan, Siena College

12:00 **Research Into Alkali Use in a Hybrid Optical Pumping Environment**
Patrick Flood, Siena College

12:30 PM – 1:30 PM: LUNCH (COOPER HALL – NEW YORK ROOM)

1:30 PM – 2:45 PM: SESSION IVA. OTHER (EDWARDS 103)

SESSION CHAIR: PROF. FRANK WOLFS, UNIVERSITY OF ROCHESTER

1:30 **Nozzle Design for a Small, Low-Speed, Closed-Return Wind Tunnel**
Jeremy Martin, Houghton College

1:45 **Maximizing Corner Efficiency for a Low-Speed Closed-Return Wind Tunnel**
Daniel Eager, Houghton College

2:00 **Effect of Temperature on Solar Panel Efficiency**
Jake Weeks, Siena College

2:15 **Data Analysis of an Informal STEM Program**
Dr. Michele McColgan, Dr. Robert Colesante, Shannon Sweet,
Torri Halaquist , Siena College

2:30 **TensorFlow: Machine Learning In Physics**
Josh Hayes, Siena College

1:30 PM – 2:45 PM: SESSION IVB. INSTRUMENTATION/EXPERIMENTAL TECHNIQUES (EDWARDS 101)

SESSION CHAIR: PROF. BETH PARKS, COLGATE UNIVERSITY

1:30 **Handling Missing Data in HMIS datasets with R**
Matt Johnson, Siena College

1:45 **Construction of a Magneto-Optical Trap to Cool Rubidium Atoms**
J. Kazmi, S. Streatfield, M. McGovern, United States Military Academy

2:00 **Establishing a Laser Induced Breakdown Spectroscopy (LIBS) analysis system at the United States Military Academy**
Scott Nieboer, United States Military Academy, DTRA-NSERC

2:15 **Trace Element Analysis Methods of Particulate Matter**
Erik Pohl, Colgate University

2:30 **Modifications of XRD at Houghton College**
Heather Phillips, Houghton College

SESSION IA. ASTRONOMY & ASTROPHYSICS

Probing Gas Stripping with Resolved Star-Formation Maps of Virgo Filament Galaxies

Natasha Collova, Siena College

We present a multi-wavelength study of the gas in galaxies at a variety of positions in the cosmic web surrounding the Virgo cluster, one of the best studied regions of high density in the local universe. Galaxies are very likely pre-processed in filaments before falling into clusters, and our goal is to understand how galaxies are altered as they move through the cosmic web and enter the densest regions. We present spatially-resolved H-alpha imaging results for a sample of 30 galaxies that reside in the same filament. The relative extent of the stellar and star-forming disks is a sensitive probe of environmental processing, and we use this to assess the magnitude of environmentally-driven gas depletion in the filament.

The Use of Different Isochrones with UniDAM

D Richmond, A. Mints, S. Hekker, S. Kanbur, SUNY Oswego; Max Planck Institute for Solar System Research, Gottingen

Galactic archaeology is the study of the formation and evolution of the Milky Way galaxy by reconstructing its past from its current constituents. In order to achieve this, a precise and accurate knowledge of stellar parameters for as many stars making up the galaxy is required. Large spectroscopic surveys have provided us with an enormous amount of stellar data such as surface temperatures, surface gravities, and metallicities. Researchers at the Max Planck Institute for Solar System Research in Göttingen, Germany have created a ‘unified tool’ (UniDAM) to compare photometric, astrometric, interferometric and asteroseismic data to a grid of theoretical isochrones in a Bayesian manner in order to derive a homogenized set of stellar parameters (Mints & Hekker 2017). The present research involves expanding the capabilities of this tool to include new isochrones sets. Obtaining stellar parameters via alternate isochrones yields the ability to observe the quality and increase the accuracy of the parameters derived.

Clustering Fundamental Mode RR Lyrae in Relation to the Oosterhoff Dichotomy
C. Wells, S. Kanbur, A. Bhardwaj, SUNY Oswego; University of Delhi

RR Lyrae are a type of periodic variable star commonly used as standard candles in determining the distances and structures of Local Group galaxies. When RR Lyrae of the subtype RRab (fundamental-mode) of globular clusters in the Milky Way are plotted in a period-amplitude diagram an effect known as the Oosterhoff Dichotomy is seen. This effect is thought to be relevant to understanding the formation of our galaxy. We have applied clustering algorithms to RRab data from the OGLE IV survey to attempt to construct a new boundary line for the Oosterhoff Dichotomy.

A Study of the Periods of Variable Stars in the OGLE Catalogue
B. Meerdink, M. Sodano, S. Kanbur, SUNY Oswego; University of Delhi

OGLE(Optical Gravitational Lensing Experiment) is a catalog of variable stars. The periods of 88,840 OGLE variable stars were calculated using the three programs: Period04, Conditional Entropy, and Analysis of Variance to reproduce a previous work. Discrepancies were found between some methods and OGLE.

IceCube Neutrino Observatory
Pouya Tanouri, University of Rochester

The IceCube Neutrino Observatory is one cubic kilometer of deep Antarctic ice instrumented with 5160 Digital Optical Modules (DOMs). Each DOM consists of a photomultiplier tube (PMT) and a data acquisition system that detects Cherenkov radiation from highly energetic charged leptons created by neutrinos interacting in the ice. Using IceCube we can search for neutrinos from "dark" supernovae and simulate how IceCube will respond to different supernovae in the Milky Way. Simulations in IceCube are used for both background estimation and for the description of a possible signal. Our task consisted of running different simulations to provide an estimated signal caused by different supernova and neutrino oscillation scenarios. The simulated signals are injected into IceCube’s Supernovae Data Acquisition System (SNDAQ) in order to evaluate the sensitivity of IceCube neutrino detector. We also study the possibility of searching for physics beyond the Standard Model, such as the production of axions, in a galactic supernova.

Characterizing the Dark Matter Profile of the Triangulum II Galaxy
Morgan McCarthy, University of Rochester

The dwarf satellite galaxies of the Milky Way, possessing high mass-to-light ratios and comparatively close locations, make very attractive observing targets for dark matter surveys. Due to their low surface brightnesses and star formation rates, observing an excess of gamma rays from their locations could be indicative of dark matter decay or annihilation. However, these objects are challenging to study in spite of their nearness. The Ultra-Faint Dwarf Spheroidal Galaxies (UFdSphs) discovered in the last five years have inherently shallow potential wells and small numbers of member stars, making their dark matter halos difficult to examine.
The Triangulum II Galaxy, one of the Milky Way's UFdSph satellites, is an ideal dark matter observing candidate, but as yet has no halo profile. We examine its properties using the Clumpy analysis suite in an effort to extract a J factor and D factor for this halo, and thereby categorize its dark matter profile.

SESSION IB. CONDENSED MATTER & BIOLOGICAL PHYSICS

Computational Model of Neural Synapse Characteristics Using Josephson Junctions

Anthony D'Addario, Colgate University

We seek to develop an understanding of the behavior of large neuron systems using superconducting circuits containing Josephson junctions. We begin with a review of previous studies that have shown Josephson junction neurons acting as biologically realistic models for neurons. The JJ neuron has reproduced mechanisms similar to action potentials, refractory periods, firing thresholds, as well as other characteristic properties of neurons. A review of the JJ axon is also included, followed by a discussion of a proposed three-stage Josephson junction circuit to model the complicated behavior of neural synapses. The JJ synapse model will include a Learning Gate that compares the time between two neuron pulses, a Memory Cell that stores flux proportional to the output of the Learning Gate, and a Variable Attenuator that varies the synaptic weight between two neurons. Previous work has shown a working model for the Learning Gate and our results show the Learning Gate working in conjunction with the Memory Cell. Currently, we are testing the Variable Attenuator circuit before combining the three separate circuits together.

Nonlinear Dynamics of Vortex-Breather Collisions

Stephen Paolini, Colgate University

Breathers and vortices are two solutions to the equations that govern the coupled nonlinear dynamics describing Josephson junctions in a ladder array. An indication of the interaction of these two solutions is a "pinning event," where the breather stops the progress of a moving vortex. This indication has yet to be observed in any system to date. We have collected experimental data, which resembles such events. However, we cannot observe every junction's behavior in our experimental setup, so we simulate the experiment with numerical integrations to generate theoretical data with which we may compare the experimental. In simulating such collisions, we hope to better understand the dynamics Josephson junctions and that of coupled nonlinear systems. Furthermore, we found that we could simulate thermal noise through linear interpolation of a standard normal distribution of random numbers sampled at a frequency greater than the characteristic frequency of the system.

SEM Analysis of NiTi Welds and Properties, Including Design of Strain Stage for In-situ Measurements
Jonathan Ballard, Houghton College

Laser welded NiTi wires were analyzed using Scanning Electron Microscopy (SEM) for use in an electric generator. The welds between the NiTi shape memory alloy and its mounting rings must be strong enough to withstand loading and thermal cycling. Microstructure in the weld revealed dendrites that look like Ti_2Ni, which could be a good reason for weld fatigue due to Ti_2Ni's brittle structure. Some cracking was observed, most likely due to the Ti_2Ni inelastic composition. Ti_2Ni can affect the shape memory properties of these wires. A temperature-controlled strain stage has been designed for in-situ imaging to observe these structures as they are being stressed physically and thermally.

Optical Properties of Van der Waals Materials
Luke Milbocker, Rensselaer Polytechnic Institute

Layered crystals have received the attention of many researchers in recent years following the discovery of graphene by Andre Geim and Kostya Novoselov in 2004. The constituent layers of these crystals are held together by weak Van der Waals forces, allowing researchers to isolate atomically thin monolayers and study their unique properties. The two-dimensional structure of these materials has a strong impact on their optical properties, including a strong dependence of the band gap on layer number and pronounced excitonic effects. With a library of these "Van der Waals materials" to choose from, it is possible to fabricate heterostructures that combine the characteristics of multiple materials, allowing a high degree of customizability. The unique and customizable properties of Van der Waals materials gives them great potential as the basis of new electronic and photonic devices, and for the study of novel physical phenomena.

Synthesis of Two-Dimensional Materials
Mayuka Sasaki, The College at Brockport, Department of Physics

Graphene is a two-dimensional (2D) semi-metal material consisting of a single layer of carbon. Due to its interesting and unique electrical, optical, thermal, and mechanical properties, synthesis of high quality graphene is essential in the development of devices that make use of 2D material properties. One way to study graphene growth is in an ultra-high vacuum(UHV) chamber. In order to get an ideally low pressure for the graphene growth, the whole chamber needs to be heated up to above 100°C for a several days (bakeout). After bakeout, silicon carbide (SiC) substrate can be used for graphene growth with being heated by an e-beam heater, supplying emission current at the back of the sample. After graphene growth, it is important to study its surface (topography, crystal structure, etc). Low energy electron diffraction (LEED) is used to obtain the diffraction pattern and to characterize the surface properties of samples.

Investigating the Incorporation of Antimicrobial Elements into 3D Printed Products

Jolene Cobb, Siena College

In this seminar, I present an experiment that demonstrates how antimicrobial nano particles can be incorporated into 3-D printable polymers such as Acylonitrile Butadiene Styrene (ABS) and Poly Lactic Acid (PLA). ABS AND PLA are assessed in combination with silver nanoparticles to design antibacterial and antifungal products. I used commercially available fused deposition and stereolithography 3-D printers to create silver nano-composites via dissolution deposition and in-situ formation of nanoparticles, respectively. The results of this experiment provide information about the possibility to enhance 3D-printer-based manufacturing with antimicrobial products, and opens a variety of promising practical applications.

SESSION II. POSTER SESSION

Inkjet Printed Nanocrystalline Inorganic Perovskite Films: the Novel Solar Cells

Benjamin Swanson, Ian Evans, Andrew Yost, F. Guzman, M. Shekhirev, J. Teeter, N. Benker, S. Sikich, A. Enders, P. Dowben, A Sinitskii, Carolina C. Ilie; Department of Physics, SUNY Oswego; Department Physics and Astronomy, University of Nebraska-Lincoln; Department of Physics, California State University-San Bernardino; Department of Chemistry, University of Nebraska-Lincoln; Department of Chemistry, Doane College, Crete, NE; Physikalisches Institut, Universität Bayreuth, Bayreuth, Germany

We discuss herein the halide based perovskite solar cells (HPSCs). This type of solar cells have low cost, impressive power conversion efficiency, and long carrier lifetimes and diffusion lengths, which are remarkable results. A novel approach is to use inorganic based HPSC materials, which bring a variety of advantages. CsPbBr3 quantum dot (QD) inks have been used in an inkjet printer to print photoactive-perovskite QD films. The current-voltage I(V) and capacitance-voltage C(V) transport measurements indicate that the photocarrier drift lifetime can exceed 10 milliseconds for the CsPbBr3 quantum dot printed perovskites films. The successful printing of photoactive-perovskite QD films of CsPbBr3, shifts the paradigm towards the rapid prototyping of various perovskite inks and multilayers as an optimal solar cell type of the future.

Simulating Impeller Mixing Under Various Conditions

Heather Phillips and Jonathan Durbin, Houghton College

Impeller mixing, owing to its widespread industrial use, can cause significant financial losses if not performed efficiently. Computational fluid dynamics (CFD) can greatly aid in the design of mixing systems when it is sufficiently accurate. For this work, fluid mixing is performed using an A200 impeller operating in a baffled tank. Simulations were performed of this setup using different approaches and under various operating conditions. Results are compared to available experimental data to guide the development of an overall ANSYS Fluent mixing prediction methodology. Qualitative trends of the experimental data were successfully predicted and discrepancies were generally less than 20%. Overall, the methodology appears promising and will be used in the future to make more detailed predictions of mixing when the flow is transitional – a historically challenging task. Additionally, the approximate solution approach utilized here will be further examined in an attempt to reduce discrepancies between the simulation results and those of the experiments.

A Phoswich Detector System to Measure Sub-Second Half-Lives using ICF Reactions

Katelyn Cook, Micah Coats, Mark Yuly, Stephen Padalino, Craig Sangster, Sean Regan, Houghton College, SUNY Geneseo, Laboratory for Laser Energetics

The $^{3}H(t,\gamma)^{6}He$ cross section has not been measured at any bombarding energy due to the difficulties of simultaneously producing both a tritium beam and target at accelerator labs. An alternative technique may be to use an ICF tt implosion at the OMEGA Laser Facility. The $^{3}H(t,\gamma)^{6}He$ cross section could be determined in situ by measuring the beta decay of ^{6}He beginning a few milliseconds after the shot along with other ICF diagnostics. A dE-E phoswich system capable of surviving in the OMEGA target chamber was tested using the SUNY Geneseo pelletron to create neutrons via $^{2}H(d,n)^{3}He$ and subsequently ^{6}He via $^{9}Be(n,\gamma)^{6}He$ in a beryllium target. The phoswich dE-E detector system was used to select beta decay events and measure the 807 ms half-life of ^{6}He. It is composed of a thin, 2 ns decay time dE scintillator optically coupled to a thick, 285 ns E scintillator, with a linear gate to separate the short dE pulse from the longer E tail. Funded in part by a grant from the DOE through the Laboratory for Laser Energetics.

Cavity Optics for Frequency-Dependent Light Squeezing

Natalie Macdonald, Laboratoire Kastler Brossel, National Science Foundation

In gravitational wave detection, frequency-dependent squeezed light sources will become a method to increase signal sensitivity. This poster describes a method to solve an open experimental issue with frequency-dependent light squeezing by using Python programming simulation.

Research of Protostellar Outflows

Kassidy J Howard, SUNY Fredonia

Protostellar outflows, which are ubiquitous in the star formation process, remove mass and angular momentum from the forming star and trace the underlying mass accretion process. In an effort to better understand how outflows evolve and how they regulate star formation, we have previously measured the dynamical properties for a large sample of isolated protostellar outflows. The goal of this present research project is to assemble complete spectral energy distributions for each protostar, calculate evolutionary signatures for each object, and place them into a relative evolutionary sequence, so that we may study how outflows evolve as protostars evolve.

Analysis of Dark Frames and the Consistency of Flat Field Frames
Sean Dempsey-Gregory, SUNY Fredonia

A 17 inch PlaneWave Instruments telescope with a SBIG STT-8300M CCD camera was recently installed on the State University of New York at Fredonia campus, for use in education, outreach, and research. Our current goal is to characterize the noise properties of the camera, in particular the noise added by calibration procedures, so that we are able to minimize the noise added by calibration to our science images. In order to achieve this goal we have analyzed the relationship between the number of dark frames used and the noise in the combined master dark frame. We have also performed a preliminary analysis on the stability and consistency of flat field frames across different nights.

Study of Capillary Condensation for Different Geometries: Biophysical Applications
Dylan Richmond, Ian Evans, Ildar Sabirianov, Julia D'Rozario, Marie T. Romano, and Carolina C. Ilie, SUNY Oswego

With the growing global demand for fresh water, SUNY Oswego has launched a Fresh Water for All initiative in which students come up with solutions to bringing fresh water to areas in need through scholarly research. Here we discuss the phenomena of capillary condensation in various confined geometries, with a special regard to the biophysical applications and the Fresh Water for All campaign. Thermodynamic principles are applied to explore phase transitions, specifically transitions between full-film, full-empty, and film-empty as well as the triple point. The grand free energy is derived and Young's equation is used with a dimensionless notation to analyze the shape of the meniscus.

An interactive visual interface for the determination of similarity patterns in the Fourier spatial frequency spectrum of laser speckle
Sam Payne; Lisa Chan; Wei Cheng Lin; Stewart Russell, The City College of New York; SUNY Binghamton; Dartmouth College

Laser speckle from particles that are smaller than the wavelength of light resemble a random Gaussian field, but can be shown to contain a characteristic spectrum in frequency space. Speckle is caused by not only the instantaneous microstructure of nanoparticles in suspension that will fluctuate as they reorganize, but also by the magnetic and optical properties of the scattering medium itself. Here we demonstrate interactive tool that can be used to define similarities between seemingly random scattering fields. Optimization of the Fourier spatial frequency spectrum gives a representative pattern that can be directly correlated to the transport properties of the particles.

Warm Dense Matter Stopping Power Experiment and Analysis with OMEGA

Yuxuan Cao, University of Rochester

The range of energetic charged particles in dense plasmas is a critical factor in inertial fusion implosions. To attain ignition, the assembled deuterium-tritium (DT) fuel must be sufficiently heated through the stopping of the energetic 3.7 MeV alphas products of DT fusion reactions. Experiments to measure the stopping power of plasmas on 3.7 MeV alphas were performed at the Omega laser facility. The results of these experiments will be reported, as well as a comparison to various cold and plasma stopping power models.

Neutron and Proton Emission in Models of Nearly Elastic Neutrino-Nucleus Interactions

Jeremy Hartse, University of Rochester

Neutrino oscillation experiments rely on the final state of particles to measure the energy of neutrinos, and neutrino detectors don't efficiently measure the energy of neutrons or low momentum protons emitted in these reactions. The goal of this project is to use the neutrino interaction simulation, GENIE, to study neutrino events with different models of collision processes, and compare the kinematics of the emitted nucleons in the interactions. Two nucleon emission is of particular interest, and processes that contribute to this include meson exchange currents, short range correlations and final state interactions. Comparing the kinematic distributions of these different models will allow us to see which ones fit the actual data from the MINERvA experiment.

SESSION IIIA. NUCLEAR AND PARTICLE PHYSICS & ASTRONOMY AND ASTROPHYSICS

Fuzzy Cold Dark Matter

Nolan Smyth, Colgate University

Much of our current understanding of dark matter (DM) stems from numerical simulations of the large scale structure of the universe and observations of dark matter-dominated halos. For many years, the Weakly Interacting Massive Particle (WIMP) has been the most prominent candidate put forth as a model of DM. However, this paradigm is currently shifting due to conflicts with the current WIMP model and observations of dark matter-dominated dwarf galaxies. In particular, WIMP simulations are not in agreement with the number and matter density of these dwarf halos. In this work we examine an alternative DM candidate, an extremely light scalar field that shares the successes of the WIMP model while addressing some of its failures. This Fuzzy Cold Dark Matter (FCDM) model is understood by solving the non-relativistic field equations that govern its motion and comparing these results to observational data. We also consider possible self-interactions of FCDM and examine whether certain conditions could lead to repulsive self-interactions.

Partially Interacting Dark Matter, Dark Disks, and Dark Plasma

Derek Sherry, Colgate University

Many observations have provided evidence for the existence of dark matter. However, a variety of experiments are making the most studied dark matter candidate, the WIMP, look increasingly improbable. Many of the problems with WIMP dark matter can be solved through the introduction of subdominant component of dark matter that has strong self-interactions. Different types of this self-interacting dark matter could form a pair plasma with collisionless shocks, or a dark galactic disk similar to the baryonic disks we can see today. Both of these possibilities introduce interesting dynamics that could leave signatures observable by astronomical observation.

Measurement of the Transverse Doppler Shift using the Mossbauer Effect
Micah Coats, Houghton College

The Mossbauer effect, which is the recoilless emission of a gamma ray from a nucleus due to the absorption of momentum into the surrounding lattice structure, will be used to measure the transverse Doppler effect predicted by general relativity to occur in an accelerating reference frame. The low-activity ^{57}Co Mossbauer source for this experiment is made by electroplating ^{57}Co onto a stainless steel foil that is then heated inside a vacuum chamber to diffuse the ^{57}Co into the crystal lattice. To observe the longitudinal Doppler effect the Mossbauer source will be placed collinearly with a NaI and CdTe coincidence detector pair, such that a stainless steel foil absorber disk between the source and CdTe detector can be rotated at an oblique angle to the collinear line. The transverse Doppler shift may be measured by rotating the disk such that its velocity is perpendicular to the line though the source and detectors. Details and results from the electroplating and diffusion process will be presented.

Can Stars Exist Without Rotating?
Noor Muzammal, S. Sahijpal, Volker Maiwald, M.I.T, German Aerospace Center (DLR)

The basis of this research is on the idea - Can stars exist without rotating? Stars rotate due to the conservation of angular momentum. This can be changed, but only by external forces. It is theoretically possible, that a stellar object is subjected to a force which can cancel out its angular momentum completely. In order for this to occur, the external force must have the same direction and magnitude of the angular momentum. In this research, tidal locks of rotation are taken a closer look at in order to avoid confusion with a “lack of rotation.” Tidally locked bodies rotate at the same angular speed as their central bodies. The reason for their existence is gravity gradient forces, these forces cause a body to oscillate around its axis. Another way we see that the rotation of stars can be altered is by magnetic fields. My research also focuses on how stellar bodies are created by angular momentum, but can exist without it. Because it is very unlikely, my research only focuses on certain scenarios for the loss of angular momentum.

Search for Type Ia supernovae and other transients in SDSS
Ouail Kitouni, Ryan Rubenzahl, University of Rochester

Type Ia supernovae are transient astronomical events that occur due to the explosion of a white dwarf star.
They are extremely bright ``standard candles;" their intrinsic luminosity can be estimated and used to measure distances on cosmological scales.
Although most Type Ia supernovae are found with imaging surveys, it is very important to also measure their spectra (and redshifts) in order to calibrate their estimated distances.
I have investigated techniques to search for Type Ia supernovae in spectroscopic data from SDSS as part of a larger search for unusual transient events. The techniques range from simple searches for deviations of galaxy spectra from the SDSS sample average, to singular value decomposition of an eigenbasis of galaxy spectra, to machine learning approaches using random forests. I will report on the relative merits of these techniques and discuss their suitability for finding Type Ia supernovae as well as other unusual transients.

Calculating the rotation curve due to visible matter in the Milky Way Galaxy
Yufan Qie, University of Rochester

In the Milky Way Galaxy, the rotation curve is related to the mass distribution of visible matter and dark matter. By comparing the measured rotation curve with the calculated rotation curve due to visible matter, we can determine the mass density of dark matter in our solar system. The components of visible matter includes the black hole at the center of our galaxy, the two bulges, and the galactic disk. Due to their spherical symmetry (and the shell theorem) calculating the gravitational force due to the black hole and the bulges is relatively simple. Surprisingly, calculating the gravitational force due to the galactic disk is much harder. We break up the disk into numerous rings, calculate the gravitational force due to each ring, and sum the forces due to all rings. The total gravitational force, due to these four mass distributions, can be used to calculate the rotation curve due to known matter. Using the measured rotation curve, we will extract the rotation curve due to the dark matter in our galaxy.

SESSION IIIB. INSTRUMENTATION/EXPERIMENTAL TECHNIQUES

Radio JOVE
Cristian Almodovar, Siena College

Hands on project with NASA's Radio JOVE. Once assembled, Radio JOVE is able to detect radiation from Jupiter at a frequency of about 20 MHz. This fairly cheap kit allows you to assemble a radio telescope from common parts. In this seminar I describe the detector and our efforts in replacing the included antenna with a longer antenna made out of different material or with multiple antennas.

The Gravity Battery
Clare Reilly, Siena College

Green energy is an important resource that modern science continues to build upon. However, current methods of harnessing green energy are neither consistent in their generation nor easily stored. The gravity battery is a green source of electrical power that stores potential energy through the use of a gear train and weights. The falling weight creates rotational motion in a gear train that then drives an electric generator. This method will be able to more steadily output electricity that can be used for applications such as charging a cellphone battery.

3D Object Scanner
Timothy Ladeairous, Jon Farrel, Siena College

Taking an object and making a physical 3D copy of it is the ultimate goal of my project. To do this I am using a 3D scanner and researching how to convert a scan to a printable object file. A previous student created the 3D laser scanner that I have spent the last school year improving. This machine consists of an Arduino board, a line laser, a USB camera, and a motorized stage. The scanner can work and collect and plot a 3D image. A 3D scanner requires moving parts, on this scanner, the object sits on a rotating stage, on other scanners the laser camera system rotates about the object usually on an overhanging arm. We are presently working to create a new mounting system. This looks like a promising way of manufacturing in the near future.

Wild Life Trail Camera vs. Raspberry Pi Camera
Brandon Watt, Dr. McColgan, Siena College

The Browning trail camera dark ops elite model BTC-HDE is a functional high end wild life camera. Yet a near similar wild life camera can be constructed through the utilization of the raspberry pi as well as raspberry pi accessories. This alters the fundamental need of purchasing such a wild life camera when a complementary one can be assembled. Exactly how close in specifications that the raspberry pi camera can get to the trail camera is the challenge and task I look to achieve.

Research Into Alkali Use in a Hybrid Optical Pumping Environment
Patrick Flood, Siena College

We are designing a method through which we can transport alkali samples in glass ampoules to a vacuum system without exposing the contents to air. If the sample is exposed, the surface oxidizes and causes the sample itself to become unusable due to the difficulty to break through the oxidized sample and the high temperatures required to do so. After transporting the ampoule, we use a heating system to free the alkali sample from the ampoule itself and increase the vapor density for use in hybrid optical pumping research. This involves the use of a pump laser to optically pump Rubidium and Potassium vapors in order to provide a source for the generation of spin polarized electrons without the use of difficult gallium arsenide crystals.

SESSION IVA. OTHER

Nozzle Design for a Small, Low-Speed, Closed-Return Wind Tunnel

Jeremy Martin, Houghton College

Wind tunnels are used to characterize objects aerodynamically (e.g., measure lift and drag as a function of air velocity). They are critical in the design process of many products, including cars and planes. At Houghton College, a wind tunnel is currently being designed and built. One of the most difficult components of a wind tunnel to design is the nozzle, which contracts the air to produce a high-speed flow immediately upstream of the test object. This is difficult because the nozzle must be designed to produce a uniform flow at the exit to get an accurate representation of how air flows over the object. Furthermore, to improve flow uniformity and to increase efficiency, boundary layer separation is to be avoided inside of the nozzle. For the present wind tunnel, several commonly used nozzle designs were tested in order to determine which best fulfills the requirements above. These nozzle designs were tested using viscous, turbulent air flow simulations in ANSYS Fluent. Results and conclusions will be presented and future work highlighted.

Maximizing Corner Efficiency for a Low-Speed Closed-Return Wind Tunnel

Daniel Eager, Houghton College

A low-speed closed-return wind tunnel is being designed and built at Houghton College. To aid in the design of the wind tunnel, empirical correlations were used to predict stagnation pressure losses in different sections of the wind tunnel based on design choices that were made. This was used to roughly size the wind tunnel, but some components need more detailed design – the corners are an example of this. In corners, turning vanes are commonly used to help minimize the stagnation pressure loss that is associated with changing the direction of the flow. To determine the optimal number of vanes, simulations were conducted using ANSYS Fluent. Vanes with an airfoil cross-section were utilized since they are more efficient than single-walled vanes, are better equipped to handle fluid flows at different incoming angles, and are commercially available. The numerical results will be presented and future work discussed.

Effect of Temperature on Solar Panel Efficiency
Jake Weeks, Siena College

Photovoltaic panels create energy by converting solar radiation into electricity. The amount of power generated by these panels can be affected by the temperature around the panel. I developed an experiment in which I could heat up and cool down a PV panel inside of a Styrofoam cooler and record the voltage and current across the panel, as well as the instantaneous temperature of the cooler using a thermistor. Based on my experiment, it can be noted that an increase in temperature would cause the voltage across the panel to decrease linearly. The current during the experiment was held constant, and therefore I observed an indirect linear relationship between the temperature of the panel and its efficiency.

Data Analysis of an Informal STEM Program
Dr. Michele McColgan, Dr. Robert Colesante, Shannon Sweet, Torri Halaquist , Siena College

Siena College hosts a STEM based program called Urban Scholars on Saturdays during the school year for middle school students within the Albany area. The program provides an opportunity for students to explore science, technology, arts, etc. with materials that may not be available to them otherwise. Students are encouraged to attend from fifth to eighth grade to measure growth and comfort within these subjects, and hope to instill a desire for students to finish high school and even continue their education. Our project analyzed data from student's self-reported survey data regarding interest in STEM subjects as well as their satisfaction with attending the program to measure the impact that Urban Scholars is having on students.

TensorFlow: Machine Learning In Physics
Josh Hayes, Siena College

Technology, like people, is constantly evolving and while it’s nearly impossible to describe just how rapidly these changes are occurring, to put it into perspective; we have reached a point where machines may be able to reason, with the right guiding hand of course. The world of artificial intelligence has constantly been making breakthroughs, and today many can contribute to this growth with access to a computer through frameworks such as TensorFlow. By understanding the fundamentals of machine learning, one can readily apply this knowledge to a wide range of fields of study or data sets. In this presentation, I will discuss the general principles behind machine learning and more specifically how it pertains to filtering a data set.

SESSION IVB. INSTRUMENTATION/ EXPERIMENTAL TECHNIQUES

Handling Missing Data in HMIS datasets with R
Matt Johnson, Siena College

This research work focuses on applying recent Data Science tools to handling and optimizing missing data in the largest regional Homeless Management Information System (HMIS) in New York State, administered by CARES, which supports local communities to create a system of care to prevent and end homelessness. Databases collected by homeless shelters are strongly affected by missing data. We developed a set of computational tools to optimize the traditional listwise deletion method. Our optimized technique removes a specific list of respondents and variables that maximize the number of data points that survives listwise deletion. This method represents a great improvement over a simple listwise deletion method, which leaves no respondents for statistical analysis when applied to the whole HMIS dataset. We implemented the algorithm in R language, which can provide a simple, portable, cost-effective platform for CARES to improve the quality of their dataset. By increasing statistical predictive accuracy, homeless shelters can better accommodate resources, to the benefit of local communities.

Construction of a Magneto-Optical Trap to Cool Rubidium Atoms
J. Kazmi, S. Streatfield, M. McGovern, United States Military Academy

Many experiments in atomic physics rely on lasers tuned to specific atomic transitions. One such experiment is the cooling of Rubidium atoms in a magneto-optical trap (MOT) to produce a source of cold atoms. As part of a new laboratory construction, we construct laser systems for use in establishing a MOT. Included in this work is rough tuning commercial-off-the-shelf (COTS) diode lasers to the appropriate wavelength (780.24nm), obtaining a saturated absorption spectrum for Rubidium, establishing an electronic locking circuit to lock to the cycling and repump transitions, and the constructing the necessary RF components to fine tune the laser frequencies for red-shifted light.

Establishing a Laser Induced Breakdown Spectroscopy (LIBS) analysis system at the United States Military Academy
Scott Nieboer, United States Military Academy, DTRA-NSERC

The goal of this independent laboratory work is to establish a Laser Induced Breakdown Spectroscopy (LIBS) analysis system at the United States Military Academy (USMA) that can be used for various material analysis applications. Although the basic principles of LIBS is relatively straightforward, there are many technical challenges to establishing a safe and reliable analysis tool. This presentation will cover the basic principles of LIBS, the status of the USMA LIBS system, the summary of preliminary data collected, and the potential for LIBS to be used for post-detonation nuclear forensics.

Trace Element Analysis Methods of Particulate Matter
Erik Pohl, Colgate University

Ambient air pollution is an issue that plagues developing countries around the world, posing significant threats to both human and environmental health. This study begins to evaluate three methods for performing elemental analyses of particulate matter samples: total reflection x-ray fluorescence (TXRF), inductively coupled plasma - optical emission spectroscopy (ICP-OES), and carbon combustion analysis. Using a standard reference particulate matter sample from the National Institute of Standards and Technology, this study aims to show the ability of the aforementioned methods to produce accurate and reliable data on the elemental makeup of particulate matter samples. After attempting several variations of our methods, our data is thus far inconclusive but does show promise for conducting a fully comprehensive source apportionment study in the future.

Modifications of XRD at Houghton College
Heather Phillips, Houghton College

Modifications and safety features of a 40 kV Bragg–Brentano theta-2 theta x-ray diffractometer (XRD) are being completed at Houghton College for the purpose of studying texture transformations in thin metal films. The sample and detector position are controlled by separate stepper motors that drive along a semicircular track. A Vernier Student Radiation Monitor measure the number of radiation counts while scanning along the track. Using Bragg's law, the out-of-plane lattice distance of various crystal orientations is correlated to certain values of 2-θ. Comparing the area fraction of the integrated peak intensities, the texture of the thin metal film can be determined.

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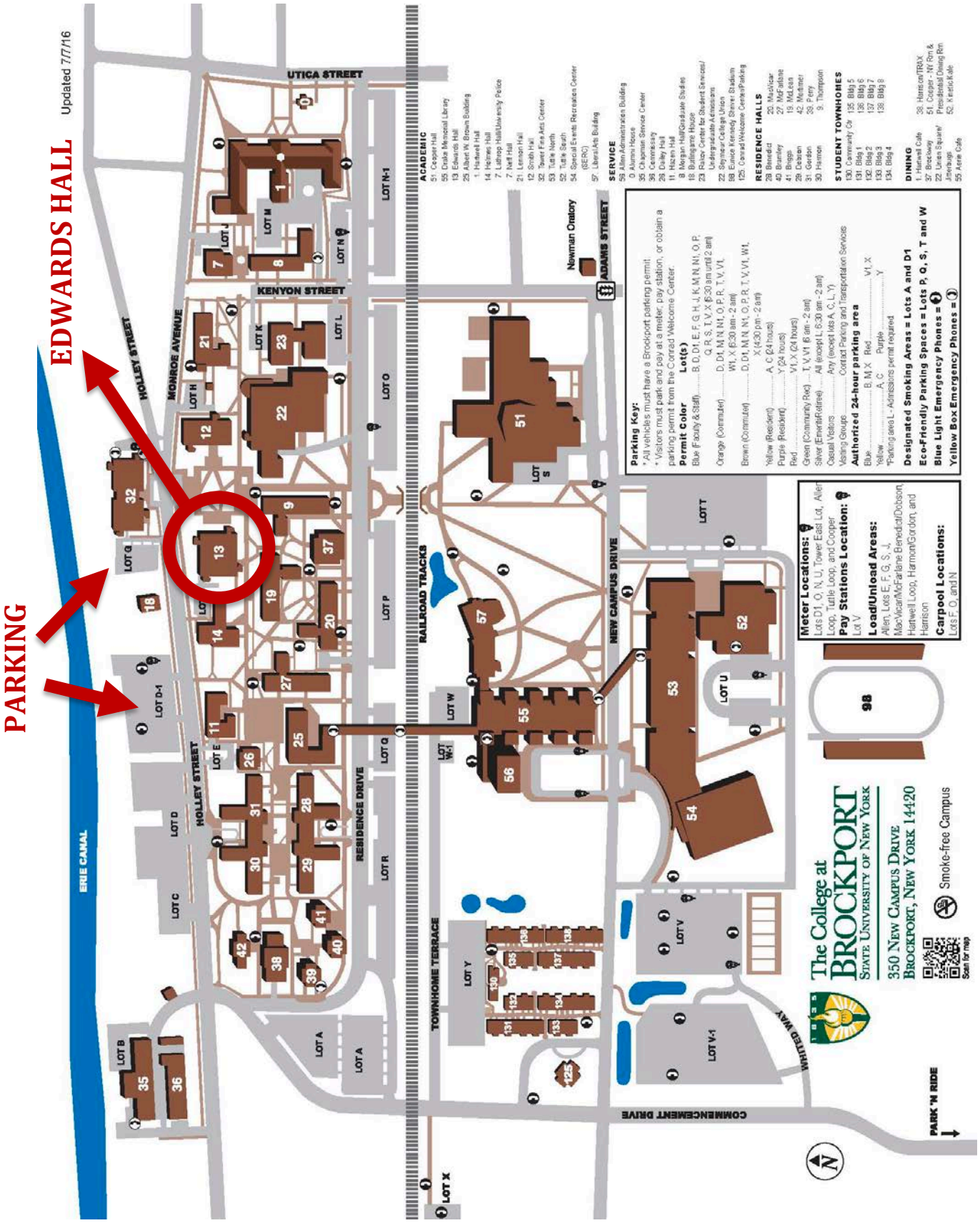
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