Senior Thesis Presentations

Part 1: Tuesday, June 6, 2017

Weniger 304, 3:00-5:30pm

3:00 – 3:10
Ian Founds: *Solution Method and Error Evolution of Student Responses to Chain Rule Problems within a Thermodynamics Course*
Advised by Corinne Manogue

3:12 – 3:22
Hazel Betz: *Repair of a Scanning Tunneling Microscope and Retesting for the Formation of Pyramidal Structures Formed on Sputtered Germanium (110)*
Advised by Shirley Chiang, UC Davis

3:24 – 3:34
Matthew Dickie: *Conductivity Mapping of Graphene Using Terahertz Spectroscopy*
Advised by Yun-Shik Lee

3:36 – 3:46
Allyson Peterson: *Student Interaction with Online Pre-Lecture Videos and how it Influences Grades*
Advised by KC Walsh

3:48 – 3:58
Tallon Korn: *Project BoxSand: Learning Analytics and Educational Data Mining*
Advised by KC Walsh

4:00 – 4:10
Willis Rogers: *Gravitational Coupling of Uniformly Rotating Computationally Resolved Stars in Protostellar Star-Disk Systems*
Advised by Kathy Hadley

4:12 – 4:22
Mirek Brandt: T*he Impact of Crystal Morphology on the Opto-Electronic Properties of Amorphous and Organic Crystalline Materials*
Advised by Matt Graham

4:24 – 4:34
Garrett Plunkett: *Electrical Transport Measurements Show Intrinsic Doping and Hysteresis in Graphene p-n Junction Devices*
Advised by Matt Graham

4:36 – 4:46
Graham Founds: *A Study of Charging Behaviors in Organic Semiconductors using Optical Trapping*
Advised by Oksana Ostroverkhova

4:48 – 4:58
Rick Wallace: *Study of Organic Semiconductors Using Time-Resolved Charge Measurements at the Microscale*
Advised by Oksana Ostroverkhova

5:00 – 5:10
Elliott Capek: *Simulating Dynein's Powerstroke Using Brownian Dynamics*
Advised by David Roundy

5:12 – 5:22
Aneeq Ahmed: *Modelling Gravitationally Coupled Modes of Protstellar Star-Disk Systems*
Advised by Kathy Hadley

Senior Thesis Presentations

Part 2: Tuesday, June 13, 2017

Weniger 304, 3:00-5:30pm

3:00 – 3:10
Jeff Shuford: *Monte Carlo Simulation of the Fuel Assembly of Oregon State University Triga Nuclear Reactor*
Advised by Tom Giebultowicz

3:12 – 3:22
Andy Baldwin: *Spatial and Temporal Damping of Fluid Perturbation at a Distance*
Advised by Elaine Cozzi, OSU Department of Mathematics

3:24 – 3:34
Keenan Cabrera: *Charge-asymmetry Dependence of Kaon Elliptic Flow in Au+Au Collisions at* $\sqrt{s_{NN}} = 27$ *GeV from STAR*
Advised by Heidi Schellman

3:36 – 3:46
Karan Cheema: *Projected Temperature and Precipitation Changes for Corvallis and Los Angeles for the 2030-2059 Period Using the Hadley Center's Regional Climate Model (HadRM3P)*
Advised by Karen Shell, OSU College of Earth, Ocean, and Atmospheric Sciences

3:48 – 3:58
Zack Dempsey: *Fourier Analysis of Smartphone Call Quality*
Advised by David McIntyre

4:00 – 4:10
Anton Schuster: *Solar Induced Florescence: A More Affordable and More Accurate Proxy for Plant Stress*
Advised by Adam Higgins, OSU School of Chemical, Biological, and Environmental Engineering

4:12 – 4:22
Alexander Jacoby: *Qualitative Comparison of Algorithms for Tracking Cell Trajectories*
Advised by Bo Sun

4:24 – 4:34
James May: *Optical Characterization of Heterostructural Alloys* $Sn_{1-x}Ca_x[S,Se]$
Advised by Janet Tate

4:36 – 4:46
Zach McKay: *Fabrication and Characterization of Nanoscale Devices Made from Molybdenum Disulfide with Viscoelastic Dry Transfer*
Advised by Ethan Minot

4:48 – 4:58
Jeremy Meinke: *Single-Molecule Analysis of a Novel Kinesin Motor Protein*
Advised by Weihong Qiu

5:00 – 5:10
Jared Cayton: *Developing a Mouse EEG (Electroencephalograph) Signal Simulator and a Preamplifier to Reduce Noise during Sleep EEG Data Acquisition*
Advised by Dr. Miranda Lim, Oregon Health and Science University

5:12 – 5:22
Rafid Chowdhury: *Go Make It Simpler: Numerical Simulation of Light Scattering and Tyndall Effect*
Advised by Henri Jansen

PH 403 Senior Thesis Presentations Part 1
June 6, 2017 3-5:30pm

Ian Founds: *Solution Method and Error Evolution of Student Responses to Chain Rule Problems within a Thermodynamics Course*
Advised by Corinne Manogue

Chain rules are critical to the process of solving many thermodynamics-related partial derivatives. This study evaluates the solution method and error evolution of students' responses to a pair of chain rule problems in an upper-level undergraduate thermodynamics course. Students' responses were categorized by solution method. Students' solution methods included implicit differentiation, substitution, differential algebra, and chain rule diagrams. In addition to categorizing students' solution methods, students' errors were sorted and analyzed. In particular, many students did not know how to hold the appropriate variable(s) constant while evaluating partial derivatives. Students also had difficulties identifying partial derivatives, and reading and building chain rule diagrams. These results could be used to improve student understanding of partial derivatives and chain rules by adjusting the order, portrayal, and intensity of course material.

Ian Founds is a native Oregonian who studied physics in his undergraduate education at Oregon State University. During his undergraduate education, he performed physics education research under Dr. Corinne Manogue. Ian hopes to attend graduate school to obtain a doctoral degree in Physics. He loves helping people learn, but is fascinated by many topics in physics and is not opposed to diversifying his research background in graduate school.

Hazel Betz: *Repair of a Scanning Tunneling Microscope and Retesting for the Formation of Pyramidal StructuresFormed on Sputtered Germanium (110)*
Advised by Shirley Chiang, UC Davis

Semiconducting materials are of immense importance due to their presence in almost all modern devices. It is possible that the surface physics of semiconductors could be used to control the nanoscale topography and properties of these materials, ultimately creating new options for device fabrication. This could result in profound implications for improvements in modern technology. In this paper, results from a previous study that characterized nanoscale pyramidal structures on the surface of sputtered germanium (110) are retested, as there may have been trace silver contamination on the sample holders used in the experiment. If there was contamination, these silver atoms could have landed on the surface of the Ge samples during sputtering and provided the nucleation points for the observed structures.

To verify the results of this previous study, troubleshooting and repair was performed on a scanning tunneling microscope in the laboratory. The repaired scanning tunneling microscope was then used to image a Ge (110) sample sputtered in a new, uncontaminated sample holder. This new sample showed no indication of pyramidal structures forming during sputtering. We conclude that silver contamination was the likely cause of the previously observed structures.

Hazel Betz is a senior at Oregon State University pursuing a physics major with a math minor. She is interested in pursuing work in solid state physics and material science. In the summer of 2016, she participated in an REU for at the University of California, Davis with Professor Shirley Chiang. She performed troubleshooting and repair on a scanning tunneling microscope (STM) and then used the repaired STM to measure the surface of sputtered germanium (110). These measurements were used to retest topological changes on the germanium observed by a previous graduate student in the laboratory. She currently is a member of professor Janet Tate's laboratory at Oregon State University where she is working with titanium dioxide thin films. Hazel plans to graduate fall of next year and then take a year off to work in industry before applying to grad school.

Matthew Dickie: *Conductivity Mapping of Graphene Using Terahertz Spectroscopy*
Advised by Yun-Shik Lee

Characterizing the optical and electronic properties of new materials is paramount to the implementation of these materials in real world devices. Of particular interest is Graphene, a novel 2-dimensional material with incredible conductivity and mechanical strength. In order to help characterize the quality of a new manufactory process, I will map the conductivity of graphene along its surface. The transmission of Terahertz light through two graphene samples, named L2 and L5, was conducted at several field strengths. The transmission was collected at every point in the sample using the raster scanning method, then the measurements put together to form composite image of the conductance of the entire sample. Using the Drude model and Fresnel's equations, an image of the conductance of the entire sample was generated. The average conductivity measured in both samples was around $5 * 10^{-3}\Omega^{-1}$, approximately 10 times the literature values, which lie around $10^{-3}\Omega^{-1}$ [5]. As the field strength increased, the average conductivity increased for L5 and decreased for L2. The discrepancy between the conductivity values measured and in literature, and the differing dependency of conductivity on field strength between the samples, suggest the detector used led to some error. There was a large degree of inhomogeneity in conductivity in both graphene samples.

Matthew Dickie grew up in Portland, OR and graduated from Parkrose High School in 2012. His love for science was forged in the crucibles of school and critical life events, like childhood trips to OMSI and episodes of The Magic School Bus, and eventually lead to him becoming a physics major. After seeing and experiencing the incredible work of the Physics Education program here at Oregon State, he intends pursue a carrier in Physics Education. In his free time, he enjoys soccer and outdoor activities.

Allyson Peterson: *Student Interaction with Online Pre-Lecture Videos and how it Influences Grades*
Advised by KC Walsh

This study examines how students were interacting with pre-lecture videos via the BoxSand website. Students of the Fall 2015 and Fall 2016 introductory physics courses at Oregon State University were studied. The course was taught as a flipped classroom in which the instructional material was provided via BoxSand. BoxSand is a website designed to provide course material for the physics course studied, and it records how students interact with the site. The purposes of the study were to show how BoxSand can be used to improve learning among introductory physics students and to explore how students interacted with pre-lecture videos.

Educational data mining was performed on data collected by BoxSand, with analysis focusing on the data generated by students clicking on links to pre-lecture videos. Formulas were written in Excel to analyze the datasets.

The major results from the fall 2015 dataset were that students tended to increase the number of videos they watched before each exam and they typically watched videos for the actual length of the video. This second result is important because the website tracks how long a student stays on a page, it does not track how the students interact with the video once they are on that page.

The most important results for the Fall 2016 dataset were that watching more pre-lecture videos tended to correlate with better grades and the students who increased the percent of videos they watched had the best chance of improving their grades in the next exam.

The methods used in this project can be expanded to analyze how students use other parts of the website to study or learn course material. When more terms of data become available for analysis, a larger picture of how students change their study habits throughout the introductory physics sequence can be made.

Allyson grew up in Stayton, Oregon where she graduated from Stayton High School in 2013. She has worked at the Memorial Union for Building Services for the past year and a half. Since last summer, she has been working with Dr. KC Walsh on the BoxSand project. Allyson will graduate this spring with a B.S.in Physics. After graduation, she will pursue a career in material or data science.

Tallon Korn: *Project BoxSand: Learning Analytics and Educational Data Mining*
Advised by KC Walsh

After BoxSand was improved by students and physics instructors, there is a growing interest in the effectiveness of the new resource. BoxSand tracks each student's exploration through the website so that it can be examined. This research looks at how BoxSand and a flipped classroom affect students learning behaviors and the success of students using BoxSand. Hoping to improve students learning and retention of materials taught in the Physics20X series, taught at Oregon State University by K.C. Walsh, Project BoxSand explores the methods of student learning behavior prior to each exam as well as how their activity changes throughout the term.

Tallon Korn Graduated from Eastside Preparatory School. After graduating he attended two years at the University of Redlands before transferring to Oregon State University. His thesis work was done alongside K.C. Walsh working on physics education. After he graduates in the spring of 2018 with a BS in physics, he plans on getting a master's in education.

Willis Rogers: *Gravitational Coupling of Uniformly Rotating Computationally Resolved Stars in Protostellar Star-Disk Systems*

Advised by Kathy Hadley

Using linear hydrodynamics equations, we modeled protostellar star-disk systems with resolved stars to determine the effect of gravitational coupling on the evolution of the star and the disk. We wanted to see if stars with low ratios of kinetic energy to gravitational potential energy, with star to disk mass ratio of 1:1, behave similarly to models of higher mass ratios. Stars were modeled as slowly rotating spheroids in uniform rotation (UR). For the systems modeled, the star in UR did not have an appreciable effect on the growth times and rotational periods of its associated disk. Gravitational coupling of the star and disk was found to be weak. The modeled disks show similar mode growth rates and frequencies when the star was represented as a point mass, and as a resolved mass in UR. Stars in UR had weak multipole moments compared to the monopole, similar to the point star case. The multipole increases with flatness of the star, differentially rotating stars which can be flatter could support stronger gravitational coupling. Models with higher mass ratios show similar multipole properties with shorter growth times and larger frequencies.

Willis Rogers grew up in Lebanon, Oregon graduating from Lebanon High School in 2010. After spending many years as a half time student at Linn-Benton Community College, Willis transferred to Oregon State University to pursue a bachelor's degree in Physics. At both LBCC and OSU, Willis took an active role in underwater robotics, competing internationally with LBCC in 2015, and regionally with OSU in 2016. During his final year at OSU, Willis joined Professor KC Walsh's team to develop the introductory physics website, BOXSAND. Willis worked with Dr. Kathryn Hadley's computational astrophysics research group, where he completed his senior thesis and presented at the Northwest APS meeting in 2017. After graduation, Willis plans to find local industry work for a few years before seeking his graduate degree.

Mirek Brandt: *The Impact of Crystal Morphology on the Opto-Electronic Properties of Amorphous and Organic Crystalline Materials*
Advised by Matt Graham

Organic aggregates and transparent amorphous metals are forming new exciting electronics such as highly efficiency solar cells and flexible displays. We present a fundamental optical study of how local morphology critically impacts the device performance of both stacked, conjugated organics and In-Ga-Zn-O (IGZO) transparent metallic materials. Derivatives of anthradithiophene (ADT): ADT-TES-F, ADT-TDMS-F, and ADT-TSBS-F were investigated through polarization-dependent optical absorption spectroscopy. While each ADT derivative has a different intermolecular stacking morphology, the intramolecular physics is dominated by their identical conjugated ring structure. We show that the morphology-dependent dipole-moment orientation drastically changes the electronic excited states, through mapping the absorption spectra anisotropy with respect to polarization. Photocells ideally need transparent metals to efficiently harvest the charges created. We present a method of extracting the band gap and Fermi energies for amorphous metals and semiconductors. To determine the Fermi energy and defect bands in such materials we developed a novel simulation code to fit data obtained from a spectroscopic technique called Photo Excited Charge Collection Spectroscopy (PECCS). We applied this technique to amorphous In-Ga-Zn-O (IGZO) transistors, however due to IP protection, we present the procedure through analysis on a simulated device. When applied to a real IGZO device, the code gave realistic values (on the order of eV) for the Fermi energy and optical band gap (Within 0.2 eV).

Mirek Brandt grew up in Eugene, Oregon where he was inspired to study physics through his high school physics course. After moving to Corvallis to attend OSU, Mirek started research late in his freshman year with Dr. Matt Graham. Although his research concerned the physics of the fast and small, Mirek aims to study gravitation and cosmology in graduate school. This summer, he will be studying detonation mechanisms of Type 1a supernovae with Dr. Boaz Katz at the Weizmann institute in Israel.

Garrett Plunkett: *Electrical Transport Measurements Show Intrinsic Doping and Hysteresis in Graphene p-n Junction Devices*
Advised by Matt Graham

Understanding the electrical transport properties of graphene provides a basis for determining its future as a potential semiconducting device that can be used for the next generation of transistors and photodetectors. Graphene p-n junctions are the fundamental building block of graphene based field-effect transistors, and thus are a logical starting point for I-V characterization. We perform transport measurements on dual topped gated p-n junctions with CVD grown graphene placed on aSiO_2/Si substrate. I-V curves show the Fermi level of graphene near the Dirac point can be directly tuned by applying voltage to the gate contact and reveal the location of the Dirac point at 3.5 kΩ is shifted -0.02 eV from its expected location at zero gate bias.

This indicates that slight intrinsic p-doping is present in the graphene sample. P-doping has been well documented in graphene based devices, and is attributed to adsorption of H_2O or O_2 molecules at the graphene/SiO_2 interface. Using the measured transfer curves of source-drain current vs top gate voltage, the conductance of the graphene sample is plotted as a function of top gate voltage and the differential change in the linear portion of the curve is used to estimate a carrier mobility for the CVD graphene as 17,400 cm^2/Vs. Previously reported mobilities for CVD grown graphene on SiO_2 typically fall in the range of 500-10,000 cm^2/Vs, indicating that the device has high mobility. High mobility is attributed to the large grain graphene flakes present in the device, which allow more uniform conduction compared with small grain flakes. When gate sweeps are performed, hysteresis is observed in the p-n junctions, as has been reported in several previous studies on graphene based FETs. Hysteresis is caused by two mechanisms: charge trapping of adsorbates, such as H_2O and O_2, at the graphene/SiO_2 interface and an electrochemical redox reaction that occurs at the interface. The presence of two Dirac peaks in the hysteretic response is the result of the dual top-gate configuration of the device.

Garrett Plunkett grew up in the country outside of Salem, Oregon. He was homeschooled through high school, but played varsity baseball at Cascade High School and studied classical piano for 10 years. After high school, he attended Chemeketa Community College, where he declared a major in physics after his freshman year, before transferring to Oregon State University in the fall of 2014.He joined the Micro-Femto Energetics Research Lab in spring 2016 under the advisement of Dr. Matt Graham. His undergraduate research is focused on determining the intrinsic doping, carrier mobility and hysteresis in graphene p-n junction devices. Garrett will graduate with a B.S. in physics with an option in optical physics. After graduation, he looks forward to possible graduate studies in optical engineering or semiconductor physics, or in entering the work force in a related field. Garrett is an avid hiker, backpacker, and mountain climber, and has been dating 2015 physics alumni and current Air Force pilot Abigail Merkel since 2015.The couple plans to get married this fall.

Graham Founds: *A Study of Charging Behaviors in Organic Semiconductors using Optical Trapping*
Advised by Oksana Ostroverkhova

We measure the charging and discharging of two organic materials, PCBM and ADT-TES-F. These materials are studied through the noncontact method of particle trapping known as Optical Tweezers, where an IR laser is used to constrain the motion of a coated or noncoated silica sphere while its positional data is recorded. The surface charge of the sphere is calculated via an induced driving electric field. We focus on the governing experimental parameters of the electric field frequency, electric field intensity, and the power of a PL inducing excitation laser. These parameters directly affect the surface charge density of a silica sphere trapped in an optical tweezer by altering the environment in which surface charge is induced. These parameters also govern how charges move in the valence and conduction bands. In previous research the electric field frequency and amplitude were set to values that did not yield a reliable surface charge. The electric field applied to the coated or noncoated spheres must exhibit a driving frequency greater than 300 Hz in contrast to the previously used 100-110 Hz. The electric field amplitude must be greater than 2000 V/m to produce reliable surface charge measurement in contrast to the previously used500-1000 V/m field. The power of that excitation laser has no effect on the surface charge density of plain silica spheres regardless of the presence of PCBM. Knowing the required parameters removes the need to have a calibration factor applied to future experiments conducted with spheres coated with the photoluminescent ADT-TES-F.

Graham Founds is a native Oregonian from Glide currently living in Corvallis. He attended Umpqua Community College for two years after graduating high school in 2012. Graham has attended Oregon State University since September of 2014 and is graduating June 17, 2017 with a Bachelor's of Science. During his time at OSU, he worked for the Oregon State Ecampus and conducted research under Oksana Ostroverkhova in the Organic Photonics and Electronics lab. Graham will be attending graduate school in physics here at OSU starting fall term of 2017.

Rick Wallace: *Study of Organic Semiconductors Using Time-Resolved Charge Measurements at the Microscale*
Advised by Oksana Ostroverkhova

Understanding charge transfer in organic semiconductors is important for developing devices like organic light emitting diodes and flexible electronics. Optical tweezers have been used in many disciplines for trapping, manipulating, and analyzing microscopic objects such as microspheres, micro-organisms, and other colloidal particles. Using optical tweezers, studies have measured the average charge on silica microspheres coated with an organic semiconductor. We take this technique further by developing a new method for measuring charge using the amplitude of oscillation for an electrically driven microsphere to measure the surface charge with a time resolution of up to 300 Hz. This method can be used for measuring the charge transfer of donor-acceptor organic semiconductors such as ADT-TES-F and PCBM.

Rick Wallace was raised in Wilsonville, Oregon and received his associate degree from Portland Community College in 2014 which is where he discovered his passion for all things physics and math. When he's not delivering pizzas, he can usually be found in the Valley library or in the OPE office working on either his thesis or physics homework. In his free time, he likes to read, run, listen to music, and play with his nieces and nephews.

Elliott Capek: *Simulating Dynein's Power Stroke Using Brownian Dynamics*
Advised by David Roundy

Dynein is a motor protein which transports cargo along tracks inside the cell. Like related motor proteins kinesin and myosin, dynein uses cellular energy to take steps with its two foot domains. Unlike kinesin or myosin, dynein's stepping pattern is highly varied: it can take steps between zero and 60nm in both the forwards and backwards directions. It is believed that dynein takes such broad, stochastic steps because its large size and several elastic regions make it more influenced by Brownian motion. To test this, we model the motor as a 2D system of elastic hinges, then simulate this model using Brownian dynamics. Preliminary results indicate such a model is capable of taking steps between zero and 25nm.These results give hope that, with further tweaking, the model may be able to generate both larger steps and backwards steps.

Elliott Capek is an undergraduate dual major in physics and biochemistry. He is interested in attending a graduate program in computational neuroscience. After school, he would like to study neural circuits using computational tools. In particular, he'd like to figure out how antidepressant drugs achieve their function at a neural level, with the end goal of creating better psychiatric drugs. In his free time, he likes gardening cactuses.

Aneeq Ahmed: *Modelling Gravitationally Coupled Modes of Protstellar Star-Disk Systems*
Advised by Kathy Hadley

In our research we computationally modelled protostellar star-disk systems with star to disk mas ration of 10. Our computational models looked at the development of density perturbations in these systems for different geometries of the system. Modelled systems with stars of varying flatness. The ratio of the star’s height and radius (rp/re) is varied between 0.1746 and 0.88095.We models stars which are rotating differentially. The results of the models created in this research were compared with the results of earlier research done by Hadley et al to see if there are consistent trends across models.

Aneeq is from the coastal city of Karachi, Pakistan. After finishing high school, they came to Oregon State University to study Physics. They are currently majoring in Physics and minoring in Queer Studies. They hope to pursue a graduate degree in Queer Studies in the future.

PH 403 Senior Thesis Presentations Part 2
June 13 3-5:30pm

Jeff Shuford: *Monte Carlo Simulation of the Fuel Assembly of Oregon State University Triga Nuclear Reactor*
Advised by Tom Giebultowicz

This study focuses on the research and development of an existing Monte Carlo program that simulates and tallies reaction channel outcomes in a nuclear reactor at the fuel assembly level. The Monte Carlo program, in its full detail, is meant to solve the N-body problem associated with reactor physics calculations. The advantage of the Monte Carlo is that the geometry of the reactor can be precisely detailed, but at expense of computing time.
This Monte Carlo program can calculate reaction probabilities and is conclusive when comparing the outcomes of the program with the experimentally determined cross sections of the various reactor elements. The code, however, is vague enough to produce doubt about the results and the program must be completed in more detail to compare results with that of other, more complete Monte Carlo programs, such as MCNP.

Jeffrey grew up and attended high school in Philomath, Oregon. Jeffrey graduated in 2007 and worked in various fields, such as construction and education, before attending OSU in 2015 to pursue his bachelor's degree in physics. Attending OSU has sparked his interest in electronics and their components and he is currently pursuing a career in either analog or digital circuity design. In his spare time, Jeff likes to work with his hands. He would like to use his talent and knowledge in construction to renovate houses and use the profit to open a trust fund that will provide aid to children that are victims of traumatic brain injuries and their families.

Andy Baldwin: *Spatial and Temporal Damping of Fluid Perturbation at a Distance*
Advised by Elaine Cozzi, OSU Department of Mathematics
A recent article by Cozzi and Kelliher [1] has presented a bound on changes in a given region based on earlier perturbation at a distance in inviscid fluid flow. This result yields a sense of "locality" which mirrors empirical behavior, where the propagation of changes to initial data propagate slowly through fluid. We extend the result for the inviscid case using the incompressible Euler equations to the incompressible Navier-Stokes equations with any viscosity. Based on this result in L2, we derive a similar bound in L^∞. We discuss the analogies between these bounds and total kinetic energy and maximum kinetic energy within a compact space of interest.

Originally from Terre Haute, Indiana, Andy Baldwin has called Portland, Oregon home since 2008. In 2013, Andy graduated from Cleveland High School in Portland and enrolled at Oregon State University. After four years at Oregon State, he is graduating with degrees in both Physics and Mathematics, after completing his thesis in mathematical fluid dynamics with Dr. Elaine Cozzi of the Oregon State Department of Mathematics. Andy also is the co-founder and CTO of FormForge LLC, a 3D printing research and development company. FormForge is currently competing in the NASA 3D Printed Habitat Centennial Challenge, with the goal of printing habitats on Mars using strictly recycled and Mars-indigenous materials. Andy serves as the lead software engineer for the company, developing the full stack for geometry creation, machine control, and data acquisition.

Keenan Cabrera: *Charge-asymmetry Dependence of Kaon Elliptic Flow in Au+Au Collisions at* $\sqrt{s_{NN}} = 27$ *GeV from STAR*
Advised by Heidi Schellman

Theory predicts that a chiral magnetic wave (CMW) at finite baryon density can induce a charge-asymmetry dependence of elliptic flow (v_2) of particles produced in heavy-ion collisions. STAR has observed that pion Δv_2 exhibits a linear dependence on charge asymmetry with a positive slope in Au+Au collisions from 27 to 200 GeV. This is consistent with the CMW picture. At lower collision energies, it was found that the charge-asymmetry integrated v_2 for negative pions is higher while for kaons, the positive charge is favored. Therefore, an observation of the same positive linear dependence of kaon v_2 difference on charge asymmetry will provide a further test on the CMW predictions in heavy-ion collisions.

In this work, we present the kaon elliptic flow measurements as a function of charge asymmetry for Au+Au collisions $\sqrt{s_{NN}} = 27$ GeV. The measurements are consistent with the CMW picture, but the statistics are too meager to yield a significant result. Theresults of this investigation will be used to determine the amount of extra data necessary to procure during the second phase of the Beam Energy Scan program at RHIC. With these extra data, the analysis will be ran again to yield a statistically significant result.

Keenan Cabrera was born in the Philippines, and shortly thereafter moved to Colorado. He attended high school in Tigard, OR where his physics teacher introduced him to the joys of physics. He moved on to become a physics major at Oregon State University. In his free time, Keenan enjoys playing the piano. After graduating, Keenan plans to take a couple years off before returning to pursue his PhD in Physics.

Karan Cheema: P*rojected Temperature and Precipitation Changes for Corvallis and Los Angeles for the 2030-2059 Period Using the Hadley Center's Regional Climate Model (HadRM3P)*
Advised by Karen Shell, OSU College of Earth, Ocean, and Atmospheric Sciences

Average monthly temperatures (maximum and minimum) and precipitation patterns are expected to change as a direct consequence of anthropogenic climate change. Temperatures are expected to be warmer in the future but precise estimates vary depending on factors like number of ensembles and emission scenario. For this study, we used 100 ensembles to simulate a recent historical period (Dec. 1985-Nov 2014) and a future climate scenario (Dec. 2030-Nov. 2059) for two cities: Corvallis, OR and Los Angeles, CA. Atmospheric forcings followed the RCP 4.5 scenario. We used results from the simulations to compare temperature and precipitation changes between the two periods for both cities. Average monthly temperatures (maximum and minimum) increased in both cities. Both cities would experience an increase in number of days above 90 °F (14 for Corvallis and 18 more days for Los Angeles). For Corvallis, average annual temperature increased from 12.8 ± 0.3$°C$ to 14.4 ± 0.3 $°C$. Average annual precipitation increased from 942.0 mm to 994.0 mm (p-value: 10^{-23}). Likewise, for Los Angeles, average annual temperature increased from 18.1 ± 0.3$°C$ to 19.5 ± 0.3 $°C$ and average annual precipitation changed from 265.0 mm to 260.0 mm (p-value: 0.32). We further analyzed changes in precipitation in terms of changes in frequency and intensity. Frequency and intensity of precipitation increased in winter months for Corvallis while non-uniform patterns were seen for Los Angeles. Summer precipitation decreased in terms of frequency and intensity of precipitation events for both cities.

Karan came to Oregon State in 2013 from Beaverton, OR. He started as a Bioengineering major but switched to a Physics major after taking PH 21X series. He conducted his research in the field of Climate modeling under Dr. Karen Shell. His hobbies include talking /listening to "anything weather", gardening and doing statistical analysis on large data-sets. After graduation, he is coming back to Oregon State University as a PhD student in Physics, but might switch to Climate Sciences or study Physics at one of many UC schools.

Zack Dempsey: *Fourier Analysis of Smartphone Call Quality*
Advised by David McIntyre

In recent decades, the cell phone has provided a convenient form of long-distance communication to the general public. Despite the technological improvements since, cell phones and their smartphone successors have suffered from a lack of clarity over a typical voice call, a result of their limited bandwidth. New phone services, such as HD-Voice and VoLTE, are meant to improve the bandwidth that cell phones can use. This claim was tested in part by performing Fourier analysis on cell phone calls that transmitted white noise from one phone to another, where the receiving phone played the surviving signal to an oscilloscope via microphone. The waveform the oscilloscope records were then Fourier transformed to reveal what frequencies were allowed in transmission. This paper reports on the results of one phone of the conversation having HD-Voice and VoLTE, as well as neither phone having these.

Zackery Dempsey grew up in Tangent, Oregon, and in 2014 graduated simultaneously from West Albany High School and Linn-Benton Community College, with an honors diploma and A.A.S. in Mechatronics and Industrial Technology, respectively. He considered pursuing engineering because of his CAD experience on the high school robotics team, but in the end preferred physics for its application of mathematics and its use in describing how the universe works (along with all the fascinating phenomena entailed). Although he will not be attending graduate school this upcoming year, he is planning on doing so soon, and will seek employment or an internship in the meantime. He enjoys playing video games and watching anime, but would like to also get back to reading and running when time becomes available.

Anton Schuster: *Solar Induced Florescence: A More Affordable and More Accurate Proxy for Plant Stress*
Advised by Adam Higgins, OSU School of Chemical, Biological, and Environmental Engineering

Farmers in the U.S. used over 21.7 billion tons of fertilizer in 2011, costing billions of dollars [1]. With the water shortages we've seen recently in California and the cost of fertilizer overuse to both farmers and the environment, there is a pressing need for affordable precision agriculture worldwide. Recently, the field of remote sensing technology has been flooded with solutions that use Normalized Difference Vegetative Index (NDVI) as their primary proxy for plant stress - environmental factors that either hurt or help plants growth. In the experiment conducted, we found that using Solar Induced Fluorescence as a proxy for plant stress in the place of NDVI could be as much as 40% more accurate and over 5 times more affordable when used on a Unmanned Aerial Vehicle (UAV) or space borne platform. We also investigated the possibilities of disease detection and resource detection through image processing. If integrated into the market, this technology could rep-resent countless billions of waste savings for fertilizer, chemicals, and freshwater as market solutions emerge.

Anton Schuster is a physics student at Oregon State University conducting research on new methods of remote sensing. His Advisor is Dr. Chad Higgins in the College of Biological and Ecological Engineering, and specializes in modelling of water transport in agricultural settings. They hope the combination of remote sensing technologies with mathematical modelling of resource usage will help benefit the environment by reducing runoff.

Alexander Jacoby: *Qualitative Comparison of Algorithms for Tracking Cell Trajectories*
Advised by Bo Sun

Cell motion allows cells to live and thrive, so the success of this motion is key to the well-being of the larger organism that the cells are a part of. If a grouping of cells fail to move in the correct direction during processes like tissue development, there can be serious negative effects on the organism. Therefore, understanding the mechanics that govern the movement of a cell can give insight into why cell motion fails. In order to develop such an understanding, the motion of cells must be observed and analyzed to gain data that can be used to construct a model of cellular motion. There are many computational algorithms developed to track cellular motion. The purpose of this experiment is to compare two algorithms: template matching and optical flow tracking, to gain a qualitative understanding of which algorithm yields the best results. Tracking of MDAMP-231-GFP, a breast cancer cell line, shows that, of the two algorithms tested, template matching fared better than optical flow tracking.

Alexander was born and raised in Baker City, Oregon where he graduated from Baker High School. He began his studies at OSU in fall 2013 as a nuclear engineering student until switching to physics in 2015.Alexander will be graduating with a B.S. in physics and a minor in mathematics. After graduation he will pursue a Master's degree in applied physics at the University of Oregon industrial internship program.

James May: *Optical Characterization of Heterostructural Alloys* $Sn_{1-x}Ca_x[S,Se]$
Advised by Janet Tate

By measuring the transmission and reflection of the metastable heterostructural alloy $Sn_{1-x}Ca_xSe$, where x ranges from 0 to 1, we show that varying the cation fraction of Ca has a nonlinear effect on the bandgap and index of refraction. In comparing the dielectric constants ε_1 and ε_2, the extinction coefficient κ, the absorption coefficient α, and the index of refraction n to values predicted from first principles using the Bethe-Salpeter-Equation, we show they agree closely, with only 2 interesting exceptions, where the bandgap is in relative agreement but the index of refraction is much lower than predicted. In this comparison, we demonstrate the limits of the Tauc method and instead use the agreement in coefficients as indicative of agreement in the bandgap. The predicted transition from orthorhombic, at low Ca fraction, to cubic rock salt structure is in close agreement with the measured, but is only observable through X-ray diffraction.

James May is a senior in Physics at Oregon State University, conducting research in metastable heterostructural alloys, specifically $Sn_{x-1}Ca_xSe$. He also served in the US Navy for nine years aboard two classes of submarine.

Zach McKay: *Fabrication and Characterization of Nanoscale Devices Made from Molybdenum Disulfide with Viscoelastic Dry Transfer*
Advised by Ethan Minot

Using a simple dry transfer process, I construct and characterize three nanoscale MoS2 devices using current-voltage curves, Raman spectroscopy, and optical and atomic force microscopy. I compare these devices, the thinnest of which was few layer (≤ 10 nm) MoS2 capable of showing photoconductance, with a current whose magnitude is affected by a split gate voltage. The thinnest device's results show mechanical exfoliation paired with a dry transfer is an economical and effective way to fabricate ultrathin gate-tunable devices.

Zach spent his first two years at Oregon State in mechanical engineering before he was inspired to switch to physics by KC Walsh, who convinced him it would be "way cooler." His career goals involve working in renewable energy research and moving anywhere sunnier than here. His background, growing up in an Iranian-American family has always made his goals both scientific and political. In his free time, he plays violin, writes and climbs things (rocks or otherwise).

Jeremy Meinke: *Single-Molecule Analysis of a Novel Kinesin Motor Protein*
Advised by Weihong Qiu
WIC Culture of Writing in Physics Award

Kinesins are intracellular motor proteins that transform chemical energy into mechanical energy through ATP hydrolysis to move along microtubules. Kinesin roles can vary among transportation, regulation, and spindle alignment within mostcells. Many kinesin have been found to move towards the plus end of microtubules at a steady velocity. For this experiment, we investigate BimC - a kinesin-5 associated with mitotic spindle regulation - under high salt conditions. Using single molecule imaging with Total Internal Reflection Fluorescence Microscopy, we found BimC to be directed towards the minus end of microtubules at a high velocity of597±214 nm/s (mean±S.D, n=124). BimC then joins the few other kinesin found so far to be minus-end-directed. However, preliminary results at low salt conditions suggest that BimC switches towards the plus end. BimC could very well be an early example of a kinesin motor protein that is directionally-dependent upon ionic strength. These results suggest multiple branches of further investigation into directionally-dependent kinesin proteins and what purposes they might have.

Jeremy Meinke grew up in Roseburg, Oregon and graduated from Roseburg High School in 2013. He chose nearby Oregon State University to study physics and was quickly happy with the decision. Jeremy is set to graduate from OSU in June 2017 with a physics major and mathematics minor. Afterwards he will attend physics graduate school at Arizona State University. He is still undecided on his area of research there, but his career path is focused possibly on industry research or data science.

Jared Cayton: *Developing a Mouse EEG (Electroencephalograph) Signal Simulator and a Preamplifier to Reduce Noise during Sleep EEG Data Acquisition*
Advised by Dr. Miranda Lim, Oregon Health and Science University

Mouse testing precedes human testing in experiments designed to study sleep. One way to quantify sleep is to measure voltage with respect to time on the outermost layer of the brain by chronic implantation of several electrode probes into the mouse skull. This is known as electroencephalography (EEG). Researchers can use this EEG data for sleep-wake staging and disease biomarker identification. However, noise from sources, such as animal movement, random electron motion, and electromagnetic radiation, can make it difficult to obtain data clear enough to identify sleep stage. In this study, a 1 mV 10 Hz signal was collected through an unshielded oscillating ~1 m long telephone wire to simulate noise similar to that seen during mouse EEG data collection. This noise was substantially reduced with a JFET common drain circuit (preamplifier). To avoid testing the preamplifier with signals from real mice, a waveform generator and a voltage divider were used to generate a signal (frequency 10 Hz and amplitude100 µV) similar to the EEG signals seen in mice (frequency 1-100 Hz and amplitude 50-100µV). Seven preamplifier circuits were placed on a head stage to test for noise reduction of EEG signals from a real mouse. This head stage did not successfully reduce noise for EEG signals produced by a real mouse. This is likely due to a circuit connection breaking before testing.

After graduating from Oregon City High School in 2013, Jared Cayton enrolled at Oregon State University. With an interest in physics and medicine, Jared chose to double major in physics and biochemistry/biophysics. He was able to learn how physics is applied to medicine in Dr. Miranda Lim's lab at the Portland Veterans Affairs Medical Center where he constructed circuits to improve mouse electroencephalogram (EEG) signals. After graduation, Jared will apply to medical school.

Rafid Chowdhury: *Go Make it Simpler: Numerical Simulation of Light Scattering and Tyndall Effect*
Advised by Henri Jansen

We construct a numerical simulation in Python to investigate the scattering of photons in two and three dimensional atomic grids. The simulations produced correlation for photons being scattered and interesting behavior at low concentrations for impurities within the grid model of matter. The simulation is based on the Tyndall Effect, where light is scattered by small particles in a very fine suspension, or colloid. We used simple numerical methods to predict behavior of photons interacting with impurities suspended in matter. In the 2D model the location of impurities is randomly chosen for a given concentration, with predetermined scattering direction for each impurity. In the 3D model, the location of the impurity and the direction of scattering is chosen randomly.

The results for both 2D and 3D models are consistent. We found a linear correlation for transmission with the concentration of impurities. We also found photons scattered to the same direction increased at lower impurity concentrations for larger grid sizes. Maximum standard deviation for data obtained is around 5%, and was lower for larger grid sizes. The results obtained for different grid sizes and impurity concentrations are comparable to theoretical predictions for light scattering.

Rafid grew up in Dhaka, Bangladesh, where he finished his GCE O and A Levels in 2011. He started at OSU in fall of 2012, as a Physics Major, and later decided to also major in Mathematics and is graduating in June 2017 with Physics & Mathematics. He has been active in the OSU community and has served in various roles in Student Leadership, including as the student union president and as a member of the Student Incidental Fees Committee. For hobbies, Rafid enjoys photography, reading, a bit of drama, world politics, and more recently has been absorbed in the world of hobby grade remote controlled vehicles.

PH 403 Honors College Thesis:

Jesse Hanson: *Stability of Accretion Disks in Binary Black Hole Systems and their effects on Merger Parameters*
Advised by Davide Lazzati

We analyze the orbital separation of binary black hole systems (BBHSs) and the time at which the gravitational and viscous timescales intersect for all combinations of black holes (BHs) in the range 1-100$M_{\odot}$.We then simulate the orbit of a single particle around one of the BHs in the BBHS over a range spanning inward from the BBHS center of mass to determine the maximum radii at which noninterfering stable orbits can exist. Using these radii as the assumed accretion disk radii, we then formulate more accurate representations of the orbital separation and time at which the two timescales intersect. This information can then be used to determine whether short gamma-ray burst emissions could occur during the merger.

Regardless of the radius of the accretion disk, the orbital separation of the BBHS when the two timescales intersect is proportional to the total mass of the BBHS, and is similar for symmetric pairs of BHs. The time at which the two timescales intersect is almost completely dependent on the mass of the BH without the disk and independent of the mass of the BH with the disk, except when the mass of the BH with the disk approaches 1$M_{\odot}$.

Jesse Hanson grew up in Scappoose, OR and first discovered his passion for physics when volunteering in the Albert Einstein exhibit at the Oregon Museum of Science and Industry. This curiosity led him to intern at the University of California, Santa Cruz Astronomy and Astrophysics Department the summer before his senior year of high school. Having completed high school, Jesse began his undergraduate career at

Oregon State University in pursuit of a physics major. Four years later, Jesse is graduating with an Honors B.S. in Physics and an Honors B.S. in Applied Computer Science, and will begin work at Fast Enterprises in August 2017. In his free time, Jesse enjoys travelling, fishing, hiking, listening to music, and spending time with friends.

Isaac Hodges: *TBA*
Advised by Davide Lazzati

Isaac spent most of his time growing up in Hillsboro, Oregon where he graduated from Hillsboro High School. He became interested in physics at a young age while reading books on space and technology and finally decided to pursue physics as a career as a Junior in High School. Isaac Spent his first two years of college at Portland Community College then transferred to Oregon State University after two years at PCC. He began working with Dr. Davide Lazzati on Gamma ray burst geometry at the end of his junior year at OSU.

Tym Mangan: *Implementation of a Test Stand for Scintillator Development*
Advised by Jeremy Danielson, Los Alamos National Lab

We built a test stand in order to measure novel scintillator materials' decay lifetimes. Radiography and imaging are valuable diagnostic tools for studying dynamic experiments, thus new scintillator materials are needed to improve the resolution of the current observational systems. A collaborative effort by the neutron imaging and x-ray radiography teams is underway to study the novel scintillator materials developed at Los Alamos National Laboratory (LANL) and by outside collaborators. Decay lifetimes and spectra are important characteristics of a scintillator material. By developing this test stand we have provided an avenue to further scintillator development. We confirm the effectiveness of this test stand by comparing known scintillator decay lifetimes of LYSO and polystyrene samples. In an upgraded implementation of the developed test stand, mixed garnet samples are characterized. Development, design, and results of the initial test stand as well as the garnet characterizations will be presented.

PH 403 Completed Thesis:

Michael Forkner: *Thermoelectric Properties of the Heterostructural Alloy Sn1-xCaxSe*
Advised by Janet Tate

By alloying face centered cubic CaSe with orthorhombic SnSe, we created the heterostructural alloy $Sn_{1-x}Ca_xSe$. The phase separated films created with a high deposition temperature acted as highly crystalline SnSe while the low deposition temperature films acted as a mix of SnSe and CaSe. For the alloyed films we observed a change in the Seebeck coefficient, carrier density, and resistivity across the theoretically predicted phase transition between the orthorhombic and cubic structures of the alloy. Across the phase transition line, there is a decrease in resistivity from 10^1 to 10^{-2} Ω cm, a significant increase in the carrier density from 10^{17} to 10^{21} cm^{-3}, and a decrease in the Seebeck coefficient from 400 to 40 μV/K. At the phase transition composition, there is the maximum in the carrier density and the minimum in the resistivity and Seebeck coefficient due the non-linear change in the properties as a function of the calcium concentration. This non-linear scaling of the properties suggests a new avenue for manipulating semiconductor properties using heterostructural alloying.

Michael went to his first year of college at Colorado State University before transferring to OSU for his second year. He finished up his bachelor's in physics in 3 years and is currently working as a Society of Physics Students Intern in Washington DC doing professional development and outreach to diverse physics communities. After the internship Michael is planning on taking a year off, apply to jobs in DC, and eventually going back to graduate school in Physics Education Research fall of 2018. In his free time, he was a high school and collegiate ski racer, enjoys reading, hiking, backpacking, and rock climbing.

Gabriel Nowak: *Testing, Development, and First Results of a Method for Measurement of the Isotropy of the One-Way Speed of Light*
Advised by Heidi Schellman

The standard model (SM) of particle physics describes many of the experimentally observed subatomic particle interactions. However, there are a few discrepancies with the SM namely: matter/antimatter asymmetry and dark energy. A current extension of the SM allows for small amounts of Lorentz Violation to fix these discrepancies. Lorentz Violating terms in the standard model extension allow for a small spatial dependence of the speed of light measurable to terrestrial laboratories as a time variation in the speed of light. We present the testing and development of a novel method for measuring the anisotropy of light[1], using the CEBAF accelerator at JLab. Variations in the electron beam's momentum are measured at the entrance and the exit of a magnetic arc, and their ratio is then plotted versus time. Time variations in this ratio correlate to a possible time variation in the one-way speed of light. A preliminary version of the method, only accounting for the largest magnets in ARC1of CEBAF, measures the isotropy of the one-way speed light to be less than 10^{-11} or one part in 100 billion, which is less precise than the current recorded value of 10^{-14}. We expect to be able to reach better than 10^{-14} levels of precision in future studies with this method.

Gabriel Nowak grew up in Iowa and graduated from Johnston High School in 2013. After deciding to attend Oregon State University Gabriel explored many different majors ranging from anthropology to chemical engineering before settling in on physics. Now, Gabriel works with various national laboratories and plans to complete his undergraduate degree in fall 2017.

Ryan Bailey-Crandell: *ISFET Characterization and Assessment of Thermal Instability*
Advised by Ethan Minot

A detailed understanding of the drift due to thermal instability is crucial to accessing the applicability of ion-sensitive field effect transistors. Herein we part the ISFET into several contributing components, each with their own independent thermal dependence. Some parameters have been previously measured to assess their contribution, such as drift due to the reference electrode and solution. The interface potential drift is simulated to show thermal dependence, an effectively drift of 8 mV/°C. We conclude from calculations of other components and experimental measurements of thermal drift that the semiconductor contribution the thermal drift is −33/°C. This is a large change that we believe may limit the applicability of ion-sensitive field effect transistors.

Ryan Bailey-Crandell graduated from Milwauikie High School in 2013. He enrolled in Oregon State University in 2013 as physics major. In 2014 he took time off school to work in electronics recycling. Ryan has been active in Physics Outreach, being involved in any outreach activities he could, both at Oregon State and beyond. He has been involved in research, working with Ethan Minot at Oregon State, Nathaniel Stern at Northwestern, and Roland Kawakami at The Ohio State. After graduating in 2018, Ryan intends to attend graduate school.

Future PH 403 Thesis Presentations:

Cody Bibler: *Biodegradation of Hexahydro-1,3,5-trinitro-1,3,5-triazine via Anaerobic & Aerobic Bacteria Isolates*
Advised by Morrie Craig, OSU College of Veterinary Medicine

Cody Bibler grew up in Dallas Oregon, a 40 minute drive North of Corvallis, until enrolling at Oregon State University in Physics. He is currently a senior under-graduate. He has worked at the Endophyte Service Lab in the veterinary medicine department under A. Morrie Craig for two years. Dr. Craig has done previous research into munitions cleanup since the early 2000's. Cody's senior project aim is to determine the underlying biophysical/chemical processes of bacteria that produce safe compounds after contact with dangerous munition compounds.

Cody will graduate in the summer term of 2017 after completing his senior thesis project and completing a final 4 credits. After this, he will either move on to a Master's degree under Dr. Craig or begin work in industry.

Kaylen Groberg: TBA
Advised by Guenter Schneider

Noah Langlie (Honors College): *TBA*
Advisor Radu Dascaliuc, Department of Mathematics

Ikaika McKeague-McFadden: *TBA*
Advised by Matt Graham

Originally a business major from the big island of Hawai'i, Ikaika McKeague-McFadden is not a traditional physics student. Developing a passion for physics late in his academic career, McFadden had to start over on a science education track. A community college transfer, McFadden began his studies at Oregon State University, Spring of 2014, joining Dr. KC Walsh's open-source introductory physics resource website, BoxSand. Finishing his Junior year, McFadden joined Dr. Matt Graham's lab and received a SURE science grant which provided full-time research experience in material physics. McFadden plans to continue his work with project BoxSand and research with the Micro-Femto Energetics Lab until he leaves for graduate school.