Oregon State University Department of Physics

SENIOR THESIS PRESENTATIONS
Part I: Tuesday, June 3, 2014
WENIGER 304
Refreshments will be served!
STUDENTS are especially welcome!

3:00 – 3:12
Jordan Pommerenck: Characterization of super-low frequency electromagnetic fields produced by an undersea transmission cable in a homogeneous fluid
Advised by Alexandre Yokochi, CBEE

3:12 – 3:24
Max Atkins: Radio Telescope Resonator Design for Observation of the 21 cm Line
Advised by William Hetherington

3:24 – 3:36
Mattson Thieme: Low temperature microscopy of organic optoelectronic materials
Advised by Oksana Ostroverkhova

3:36 – 3:48
Aaron Kratzer: A Comparison of Material Characterization Techniques: Spectroscopic Ellipsometry and Reflection Spectroscopy on Zinc Sulfide
Advised by Janet Tate

3:48 – 4:00
Brad Hermens: Adaptive Choronagraphy Using a Digital Micromirror Array
Advised by William Hetherington

4:00 – 4:10
Break

4:10 – 4:22
Heather Wilson: Real-time monitoring of chemical reactions with carbon nanotube field-effect transistors
Advised by Ethan Minot

4:22 – 4:34
Paho Lurie-Gregg: The contact value approximation to the pair distribution function for an inhomogeneous hard sphere fluid
Advised by David Roundy

4:34 – 4:46
Patrick Gollmann: Fouling Prevention by Electrically Charged Thin Film Composite Forward Osmotic Membranes
Advised by Issac Farr (HTI), David Jassby (UCR) and Bo Sun

4:46 – 4:58
MacKenzie Lenz: Nonlinear Terahertz Spectroscopy of Vanadium Oxide
Advised by Yun-Shik Lee

4:58 – 5:10
David Froman: Analysis of Nullification Methods of Hysteresis in Carbon Nanotube Field Effect Transistors
Advised by Ethan Minot

version 28 May 2014

SENIOR THESIS PRESENTATIONS
Part II: Tuesday, June 10, 2014
WENIGER 304
Refreshments will be served!
STUDENTS are especially welcome!

3:00 – 3:12
Harsukh Singh: The Effect of Inhomogenous Surface Temperature Distribution on Collagen Growth
Advised by Bo Sun

3:12 – 3:24
Louise Henderson: Calculating Crystal Properties of Bismuth Telluride Using Wien 2k
Advised by Janet Tate

3:24 – 3:36
Daniel Gluck: High-Resolution Spectroscopy and Abundance Analysis of Very Metal Poor Red-Giant Stars
Advised by Jaehyon Rhee

3:36 – 3:48
Alec Holmes: First principles study of finite temperature phase stability in (Cu,Ag,Au)In2 and metal alloys
Advised by Guenter Schneider

3:48 – 4:00
Rene Zeto: Testing the model for Min D protein oscillations in Escherichia coli
Advised by David Roundy

4:00 – 4:10
Break

4:10 – 4:22
Cord Meados: Force Measurements measured from Reflection in an Optical Tweezer
Advised by David McIntyre

4:22 – 4:34
Dustin Swanson: Effects of impurities and contact resistance in graphene field effect transistors
Advised by Ethan Minot

4:34 – 4:46
Kyle Thomas: Fibroblast Morphology During Trypsinization
Advised by Bo Sun

4:46 – 4:58

Kathleen Prudell: Determining Thickness of Zinc Sulfide Thin Films Through Optical Spectroscopy
Advised by David McIntyre
4:58 – 5:10
Cole Schoonmaker: Advised by Guenter Schneider

Earlier thesis presentations by the class of 2014

Grant Sherer (Honors College): Examining Upper-Division Thermodynamics Using the Actor Oriented Transfer Framework
Advised by Corinne Manogue

Rodney Snyder (Honors College): Electrical and Thermal Properties of Silicon and Tetrahedrite
Advised by Janet Tate

Maia Manock: TBA (summer 2014)
Advised by Henri Jansen

Daniel Speer: TBA (summer 2014)
Advised by Janet Tate

Abstracts and Biographies:

Maxwell Atkins: Radio Telescope Resonator Design for Observation of the 21 cm Line

Radio astronomy allows observations of unique objects and phenomena relating to the electric and magnetic fields of celestial objects. Radio astronomy can be performed at any time of day and is less beholden to atmospheric conditions than optical astronomy. A radio telescope designed to receive radiation at 1.421 GHz, the 21 cm line, needs a resonator designed to maximize the signal to noise ratio at this specific frequency

Radiation reflected off of the parabolic dish of a radio telescope can be modeled as diffraction through a circular aperture. This leads to an Airy disk pattern of radiation at the focal plane. An integral describing this pattern was set up and evaluated using the scipy package in python, yielding a description of the Airy disk.

The diameter was determined by noting that the resonator should be large enough to encompass the bulk of the reflected radiation while being as small as possible to limit noise entering from other sources. This compromise is reached by having a diameter that extends to the first zero of the Airy disk pattern, yielding an ideal diameter of 11.65 cm. The ideal length of a resonator for a telescope observing the 21 cm line was found via interference calculations to be $\frac{5\lambda}{4} \approx 26.38$ cm.

Bio: Max Atkins graduated from Dufur High School in Dufur, Oregon in 2009. He has worked as a teaching assistant in the introductory physics courses since March of 2012. He was treasurer of SPS during the 2011-2012 school year and became president during the 2012-2013 school year. He will be graduating from OSU with bachelor degrees in physics and math with the hope of doing cosmology research in the future

David Froman: Analysis of Nullification Methods of Hysteresis in Carbon Nanotube Field Effect Transistors

The magnitude of the hysteresis in a carbon nanotube field effect transistor (CNTFET) with a surface CNT was analyzed to determine the effectiveness of several methods of nullifying the hysteresis magnitude. A battery of V_{gate} sweeps at different sweep rates showed that the relationship between gate voltage sweep rate and the magnitude is determined to be linear with a .083 correlation. A cryostat and liquid nitrogen were used to determine that the relationship between temperature and magnitude is exponential with a .0089 correlation. Current annealing in vacuum was used to eliminate local water and hydroxide impurities in the SiO_2 insulation, lowering the hysteresis by 40%.

In controlling the hysteresis, it is possible for CNTFETs to function as nonvolatile charge storage memories, replacing other forms of nonvolatile memory due to their smaller size. They are also smaller than other types of field effect transistors, but haven't become widely used due to production problems and the hard to control hysteresis. By eliminating hysteresis in a device, CNTs provide an ideal system for studying one dimensional photophysics.

Bio: David Froman, 22 years old, graduated from Oregon City High School in Oregon City in 2009. Recieved an AAOT from Clackamas Community College in 2011. Will graduate from OSU in 2014 with a B.S. in physics, and will receive a B.S. in Mathematics from OSU in 2015. After graduation, he will be attending OSU graduate school for physics.

Daniel Gluck: High-Resolution Spectroscopy and Abundance Analysis of Very Metal Poor Red-Giant Stars

Studying the evolution of the Milky Way galaxy helps us understand our place in the Universe. Early evolution of the Galaxy can only be studied by observing stars with low metallicity values since they are the oldest stars still visible. G2 0701+6247, G2 0934+3614, and G2 1540+3200 are the three stars selected from a survey of very metal-poor star candidates for high resolution spectroscopy in order to determine the chemical composition and metallicity. Two standard VMP stars, HD 88609 and HD 122563, to compare to previous research to verify the methods used. Echelle spectra were collected by the Mayall 4-m telescope at the Kitt Peak Nation Observatory for each star and the charge coupled device images are reduced using Image Reduction and Analysis Facility. After background noise is removed, wavelength calibration is conducted using a Th- Ar lamp image as the reference. Equivalent widths for iron I & II are measured and used as paramaters for MOOG in order to determine the iron content of each star. This is used to calculate the metallicity of each star. The metallicity values for HD 88609, HD 122563, G2 0701+6247, G2 0934+3614, and G2 1540+3200 are -3.09±0.017 -2.84±0.016, -3.00±0.029, -1.66±0.022, and -3.02±0.049 respectively.

Bio:

Patrick Gollmann: Fouling Prevention by Electrically Charged Thin Film Composite Forward Osmotic Membranes

Forward osmosis provides a low energy alternative for waste water purification. One of the major issues facing this process is the formation of a foulant layer preventing fluid transfer across the membrane. In recent studies, a conductive layer added to the membrane surface allowing an electric charge to be present on the membrane, has been shown to decrease the rate of mineral fouling in reverse osmosis membranes. Through the application of a conductive layer made of carbon nanotubes on Hydration Technology Innovations, LLC. thin film composite membrane,

the applicability of the charged surface and its effects on mineral fouling was explored for forward osmosis membranes. Extensive testing was done by placing both positive and negative charges on the membrane with varying voltage potentials. This method of fouling prevention was found to have little observable effect on the membranes resistance to mineral foulants.

Bio: Patrick grew up in Springfield, Oregon, where he graduated from Thurston High School. He first learned for his love for physics from his father, a mechanical engineer, whom he would often work alongside with, and their shared love for science fiction and fantasy, the most notable of which was Star Wars. Patrick served a 2 year mission for the Church of Jesus Christ of Latter-day Saints in islands of Fiji and as a result is fluent in 3 languages. In 2011 Patrick was married to Valerie Steig, whom he has received great encouragement and support from. He also began an internship at Hydration Technology Innovations in 2011 and will continue on with them following graduation.

Louise Henderson: Calculating Crystal Properties of Bismuth Telluride Using Wien 2k

Bio: Louise Henderson was born in Milwaukie, OR then shortly lived in Minnesota until returning back to Oregon. She graduated from Canby High School in 2008 and has been going to OSU since. When Louise is not doing physics things she enjoys painting, photography, and good beer.

Brad Hermens: Adaptive Choronagraphy Using a Digital Micromirror Array

Coronagraphs have been used on telescopes for many years to block out the light of the sun or bright star to allow nearby objects to be resolved. A digital micromirror array can be used in the focal plane of a telescope to serve as an adaptive coronagraph. The system has just been aligned so very little data hasbeen gathered at this point. More will be added as data is gathered and conclusionsare made.

Bio:

Alec Holmes: First principles study of finite temperature phase stability in (Cu,Ag,Au)In2 and Al2Cu alloys

The common, implicit approximation of First principle density functional theory calculations of states in solid materials, is to assume the structure remains unchanged at low temperatures such as room temperature. Often such an approximation is very resonable, because energy added to a structures phase is relatively small compared too the total energy of typical solids. However, such an approximation is not always accurate even for simple materials like CuAl2, which has predicted C1 structure at zero temperature, but has observed C16 structure at low temperature. It has been shown for CuAl2 that entropic contributions to the free energy in the form of lattice vibrations lead to a shift between the C1 andd C16 structures at a temperatures well below room temperature, making the C16 the lowest energy structure at room temperature. Through this study the phase transition properties from C1 to C16 structures of CuAl2 and the similiar metal alloys CuIn2, AgIn2 and AuIn2 is explored using first principle density functional theory and varius local and gradient approximimations for the exchange correlation functional. CuIn2 and AgIn2 are found to have the same structural transition as CuAl2's shift from C1 to C16 structure by room temperature, while AuIn2, while AuIn2, despite its very similiar bonding structure, remained in C16 structure all the way into low temperature and does not make the transition to the C1 structure.

Bio:

Aaron Kratzer: A Comparison of Material Characterization Techniques: Spectroscopic Ellipsometry and Reflection Spectroscopy on Zinc Sulfide

Spectroscopic Ellipsometry (SE) was used long before computational tools were developed to model thin films and is a well-verified tool for materials characterization. Reflection-transmission spectroscopy (RTS) has been used by the OSU physics department to analyze thin films for many years. As an example of the utility of SE and RTS, both analysis techniques are used in the fabrication of solar panels and other semiconductor thin films. SE and RTS present non-destructive methods of analyzing the films while they are being produced, reducing the uncertainty of the quality and characteristics of the films.

The ZnS thin films were analyzed for layer thickness, refractive index, and absorption using RTS, SE, and modeling programs. RTS and refractive index values from literature were used to model film thickness based on reflection and the SCOUT modeling program was used to analyze the reflectance data. SE was used to measure film thickness and complex index of refraction and a VASE32 program was used to model the layers of the thin film. The initial goals of the experiments were to characterize the thin films and gain experience in material characterization. Secondary goals include comparing SE and RTS as possible non-destructive analysis tools and developing the most efficient method for characterizing materials at the accuracy most useful to the research team.

Bio: Aaron began his career in physics interested in applying it to renewable energy technology. He has spent his time involved in many different areas of the university, from the housing department and community dialog to research groups and the Society of Physics Students (SPS). Aaron currently facilitates SPS meetings and Journal Clubs in the department, as well as training members of the Tate lab group in grating spectroscopy. After sticking around for one more year at OSU, he plans to go to law school for Environmental Law and work as a climate activist. Some of Aaron's passions include community activism, social justice, feminism, social exercising, and mentoring/leadership development.

MacKenzie Lenz: Nonlinear Terahertz Spectroscopy of Vanadium Oxide

There is a fast phase transition from insulator-to-metal transition in vanadium dioxide, VO_2. This phase transition occurs at $67^{\circ}c$. The experiment preformed attempts to induce this phase transition using a terahertz soectroscopy. Should this phase transition be achievable with the terahertz pulse the VO_2 could be used as an optical switch. An optical switch made of this material would be much faster than current switches. Electronic communication could be greatly improved with this device. There are two different sample types, nano slot and bare samples. The nano slot sample showed a change in phase shift slightly before the critical temperature.

Bio: MacKenzie Lenz graduated from Corbett High School, Corbett Oregon, in 2010. She came to Oregon State University the fall of 2010 as a physics major. She began work in Dr. Yun-Shik Lee's lab in early 2013. MacKenzie has been a teaching assistant for the physics department for a year and a half. She is also the current vice president of the society of physics students. In her free time MacKenzie enjoys playing games with friends, reading, cooking and sewing. Next year she will be attending graduate school at Oregon State.

Paho Lurie-Gregg: The contact value approximation to the pair distribution function for an inhomogeneous hard sphere fluid

We construct the contact value approximation (CVA) for the pair distribution function, g(2) (r1 , r2), for an inhomogeneous hard sphere fluid. The CVA is an average of two radial distribution functions, which take as input the distance between the particles, |r2 − r1 |, and the average value of the radial distribution function at contact, gσ (r) at the locations of each of the particles. In a recently published paper, an accurate function for gσ (r) was developed, and it is made use of here. We then make a separable approximation to the radial distribution function, gS (r), which we use to construct the separable contact value approximation (CVA-S) to the pair distribution function.

We compare the CVA and CVA-S to Monte Carlo simulations that we develop and run as well as to two prior approximations to the pair distribution function. This comparison is done in three main cases: When one particle is near a hard wall; when there is an external particle the size of a particle in the fluid; and integrated over various regions of space. We show reasonable quantitative agreement between the CVA-S and simulation data, similar to that of the prior approximations. However, due to its separable nature, the CVA-S is suited for use in the development of classical density functionals constructed using perturbation theory.

Bio:

Cord Meados: Force Measurements measured from Reflection in an Optical Tweezer

Optical tweezers are used to trap small particles, generally in biological or atomic settings with a laser. There are many complex mathematical models used for the motion of the trapped particle and the force of the trap, however Hooke's Law gives a suitable understanding of the basic behavior.

The experiment performed used reflected light from a transparent, spherical, micron sized particle trapped in an infrared optical tweezer. Though the attempts at exactly measuring the force of the tweezer were unsuccessful, the equipment was able to distinguish whether or not a particle was trapped.

Bio: Cord Meados graduated from West Albany High School in 2010. He enrolled in OSU the following year to pursue a degree in physics. After two years, he added a math degree to his studies. Cord will graduate in 2014, and pursue a career at Intel

Jordan Pommerenck: Characterization of super-low frequency electromagnetic fields produced by an undersea transmission cable in a homogeneous fluid

Offshore renewable energy, an untapped energy resource in the United States, has the potential to stimulate job creation and diversify the world's energy portfolio. Transmission cables are used to transfer electrical power to the mainland. These cables carry a harmonic time-dependent current. This current in turn generates both an electric and magnetic field. Although the electric field can be shielded from the marine environment, it is not economically feasible to use high permeability materials to shield the magnetic field. The magnetic field induces an electric field in the water surrounding the transmission cable. The sensory perception and migration of fish and mammalian species can be caused by perturbations in the electric and magnetic fields.

This research focuses on determining the magnitude of both the magnetic field and the induced electric field. It is hoped that through a better understanding of the fields created by these transmission cables, marine conservation can be promoted and renewable wave energy can be further developed. Several analytic models are compared for the radial and axial electric field. The magnitude of the magnetic field and its induced electric field in seawater are experimentally measured, and the ability to predict the electric field through a derivation of Maxwell's equation similar to the statement by Shakur et al is evaluated experimentally. A derivation using polarization potentials (Hertz vectors) employed by Sommerfeld et al is used to model the induced electric field.

The magnetic field is measured using a Hall magnetometer. Electric fields are measured using standard reference graphite electrodes. The magnetic field is modeled using Maxwell's equations; there is excellent overlap of the experimental data and theoretical model. The traditional model of dealing with the fields directly fails to accurately model the data for a single copper conductor in both the near and far field regions. There is excellent correlation between the model proposed by Sommerfeld and the measured data.

Electric and magnetic fields, polarization potential, under-sea transmission cable, offshore ocean energy, renewable, electric wave generation, marine life

Bio: Jordan grew up in Salem, OR and home schooled through A Beka Christian Academy. He decided to major in physics after attending community college for two years. Jordan is a fifth year senior and will graduate with a B.S in physics, a minor in mathematics, and an option in mathematical physics this spring 2014. He hopes to enter the OSU graduate physics program this fall. Jordan enjoys computer graphics and digital artistry (in which he almost majored). He also actively engages in sand volleyball when the weather permits.

Grant Sherer (Honors College): Examining Upper-Division Thermodynamics Using the Actor Oriented Transfer Framework

One source of difficulty for students in Thermodynamics courses is their unfamiliarity with partial derivatives and the associated mathematical procedures. At Oregon State University, a mechanical analogue of thermodynamic systems, called the Partial Derivative Machine (PDM), has been designed. The PDM represents an attempt to make the mathematics of partial derivatives more accessible to students by not simultaneously introducing new physical concepts from thermodynamics, such as Entropy. The Interlude session associated with the upper-division thermodynamics course at Oregon State University introduces the mathematical techniques using this new learning tool, the Partial Derivative Machine. Using the Actor Oriented Transfer perspective this research examines the transfer of skills and knowledge developed with the Partial Derivative Machine in this intensive mathematical session to new physical contexts in the Energy and Entropy course and new physical contexts. Students from the course were recorded both in class and in recorded problem solving sessions to observe instances of transfer.

Bio: Grant Sherer graduated from Lake Oswego High School in 2010. At Oregon State he studied Physics with an option in Education as well as Mathematics with a Secondary Teaching Emphasis. After graduation he will be enrolled in the Professional Teacher Education in Science and Mathematics program in the OSU College of Education to pursue a Masters of Science in Science Education with the goal of being a high school Math/Physics teacher.

Harsukh Singh: The Effect of Inhomogenous Surface Temperature Distribution on Collagen Growth

Collagen is the structural unit of proteins and is involved in biological phenomemnon like cancer. This is due to the collagen production affecting dense tissue surrounding the tumour. Many physiological processes like cancer can be understood by varying a measurable physical quantity such as temperature and finding how the system reacts to this change. This study investigates the effect of an inhomogeneous temperature array on the intensity pattern of collagen. This intensity was measured as the strands per area. The entropy of the collagen strands was measured as the dispersion of the collagen strands throughout the collagen gel. The higher the dispersion of strands the higher the entropy. This study found that the collagen strands growing on surface with a greater heat flux had a higher dispersion and the growth around those areas was significantly less than the surroundings.

Bio:

Rodney Snyder (Honors College): Electrical and Thermal Properties of Silicon and Tetrahedrite

Transport measurements of conductivity and carrier concentrations were explored for thin films of In_2O_3:Sn (ITO), silicon wafers, and tetrahedrite thin films. ITO was used as a test case for high temperature transport measurements because it a well characterized semi-metal. The mobility as a function of temperature is $\mu \propto T^{\alpha}$ for a = -0.3. This proportionality is consistent with phonon dominant scattering which is consistent with the literature for ITO. Silicon was measured as a test case because it is a well characterized semiconductor that can be controllably doped *n* and *p*-type. Rectangular wafers were measured: 620-μm thick, <100>-oriented n-type Si and <111> 650-μm thick, <111>-oriented *p*-type Si. For *p*-type Si, ρ = 21 mΩcm and *p* = 6.25×10^{18} cm^{-3}, for *n*-type Si, ρ = 14 mΩcm and *p* = 9.5×10^{17} cm^{-3}. The power factors for *n*- and *p*-doped silicon were measured at $3.0\cdot10^{-3}$ W/mK^2. The measured transport properties were consistent with the literature.

The room-temperature resistivity and Seebeck coefficient of thin film variants of the mineral tetrahedrite $Cu_{12}Sb_4S_{13}$ were measured. In bulk form, tetrahedrite has shown promise as a good thermoelectric material. 360 nm thin films of $Cu_{10-x}Ag_xZn_2Sb_4S_{13}$ were produced by e-beam deposition, and were also produced with a second metal on the Cu site. The Seebeck coefficients ranged from 10 to 113 μV/K and the resistivity from 8 to 50 mΩcm. Together, these values yield power factors S^2/ρ ranging from 10^{-7} to 10^{-4} W/mK^2, approaching the range of their bulk counterparts.

Bio: I grew up in Albany, Oregon and started working on a double major in math and physics at OSU in 2010. In 2012, I started working in Dr. Tate's lab. Outside of class and research, I've continued to play soccer competitively. I'll be attending the University of Maryland for grad school in condensed matter physics starting in the fall.

Kathleen Stevens: Determining Thickness of Zinc Sulfide Thin Films Through Optical Spectroscopy

Bio: Kathleen Prudell is a 2002 graduate of Miamisburg High School in Miamisburg, Ohio. She completed a B.A. in Fine Arts from Antioch College in Yellow Springs, Ohio in 2006. She moved to Corvallis, Oregon shortly after graduating from Antioch, where she developed an interest in physics. Her hobbies include painting, hand weaving and cooking.

Dustin Swanson: Effects of impurities and contact resistance in graphene field effect transistors

Graphene is an en vogue material for analysis in materials science and experimental physics. Graphene based field effect transistors (GFET) are shown to deviate from ideal conduction due to charged impurities in the substrate layer consistent with the Drude-Boltzman theory. It is also shown that the contact resistance for GFET, which becomes significant at high carrier densities, is Ohmic. Conductivity at low carrier densities is not analyzed due to limitations of the Drude-Boltzman theory.

Bio:

Mattson Thieme: Low temperature microscopy of organic optoelectronic materials

We present a report on a new capability for low temperature microscopy of organic optoelectronic semiconductor materials. We may now perform photoluminescence (PL) and conductivity measurements as a function of temperature on a microscopic level. Testing confirmed the setup's ability to support microscopic measurements at pressures of $\approx 10^{-6}$ Torr and temperatures down to 78K. Preliminary results on high performance ADT-TES-F composite materials have been obtained including PL, of single crystals as well as donor-acceptor (D/A) spincast films, and images of microscopic D/A domains under 60-100X magnification. An increase in PL was observed with decreasing temperature in single crystals of ADT-TES-F due to a decrease in thermally activated non-radiative recombination. Microscopic images of spincast D/A composites have yielded evidence of exciplex formation at the grain boundaries, indicative of the presence of charge transfer states in these regions.

Bio:

Kyle Thomas: Fibroblast Morphology During Trypsinization

Morphological changes are quantified for fibroblasts detaching from the top surface of a collagen gel. The rate of change is plotted for varying densities of collagen.
Results are listed here when they are found.

Bio: At the time of writing, Kyle Thomas is a physics bachelor's student at Oregon State University who has worked during 2013 and 2014 in Professor Bo Sun's cell biophysics lab. Kyle used his GED to gain an Associate of Science degree from Southwestern Oregon Community College. When not being studious or laboratorious, Kyle can be found on bicycle tour or camped at a beach. When not touring or camping, he is reachable via email: thomasky at onid dot orst dot edu.

Heather Wilson: Real-time monitoring of chemical reactions with carbon nanotube field-effect transistors

Single-molecule biosensing with carbon nanotube (CNT) field-effect transistors has the potential to reveal important information about chemical and biological kinetics with high spatiotemporal resolution. This method of single-molecule sensing has proven quite challenging to employ. In a search for ways to enhance the practicality of existing protocols, we monitored the chemical reaction of diazonium reagents with CNTs in field-effect transistors.

After several experiments with carboxybenzene diazonium and benzene diazonium, we found that the chemical reaction between a diazonium reagent and CNT resulted in up to 5-fold increases in the overall resistance, R_{total}, of the transistors. Up to a 5-fold reduction in the slope of the sub-threshold region of the transistor curve was also observed. We found that the increase in R_{total} was due to three separate mechanisms: a decrease in the scattering length of the charge carriers, the presence of scattering “hot spots,” and an increase in contact resistance between the CNT and metal electrodes.

The real-time electrical data obtained from the transistor during the CNT and diazonium reaction revealed three notable characteristics. First, periodic, discrete changes in resistance were observed throughout the reaction at differing rates and magnitudes. Although the source of these discrete changes is unclear, evidence suggests that they may be caused by resonance between electrons on the CNT and neighboring SiO_2 charge traps.

Second, transistors exposed to diazonium reagents showed nearly linear increases in device resistance as a function of reaction time. Third, decreasing the gate voltage applied to the CNT channel reduced the rate of resistance change dR/dt. We propose that the rate dR/dt is directly proportional to the number of new bonds formed on the CNT sidewall, dN/dt. The predictability of how gate voltage affects dR/dt allows facile regulation of the reaction rate dN/dt. The ability to control the rate and extent of the diazonium reaction is important for the success of future single-molecule experiments.

Bio: Heather grew up on Vashon Island, WA and graduated from Vashon Island High School. After working as a retail pharmacy technician for several years, she decided to pursue an education in physics and chemistry at Oregon State University. Heather has worked in Professor Ethan Minot's lab as an undergraduate research assistant since early 2012. She will be graduating from OSU this spring with a B.S. in physics and a minor in chemistry, and will begin graduate studies at Pennsylvania State University in the fall.

Rene Zeto: Testing the model for Min D protein oscillations in Escherichia coli

The Min protein system in Escherichia coli helps the cell division process by identifying the center of the cell. This system has been modeled successfully computationally under standard conditions. There has been recent experimental interest in the cell division process for significantly perturbed cell shapes. We take the existing computational model, and extend it to such a perturbed shape. We find that the existing computational model does not agree with these newer perturbed shapes, but that several interesting conclusions about the stability of the oscillations in larger cells can still be drawn. Furthermore, we explore an alternative model as a potential avenue for future works.

Bio: