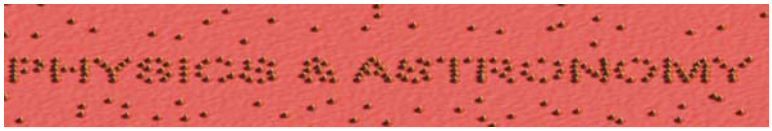

Undergraduate Research Conference 2011

Department of Physics & Astronomy

Scholar's Week

Tuesday, May 17

CF 386

Time	Presenter	Faculty Mentor
1:00	Joel Iwagoshi	Andreas Riemann
1:20	Cheryl-Ann Fujioka	Ken Rines
1:40	Brian Svoboda	Ken Rines
2:00	Drew Grennell	Andrew Boudreaux
2:20	Brandon Owens	Andreas Riemann
Break		
3:00	Dylan Kloster	Ken Rines
3:20	Rachel Arnold	Ken Rines
3:40	Shane Peper	Takele Seda
4:00	Trevor Morgan	Janelle Leger
4:20	Amanda Norell Bader	Janelle Leger
4:40		

1:00 – 1:20 PM **Joel Iwagoshi** and Andreas Riemann

Nickel Thin Film Growth on Copper Samples

In the past few years thin films deposited on single-crystal substrates have become a major focus in the field of surface science due to their novel magnetic properties. In this study we investigate the growth of nickel films on a copper sample. Nickel is chosen for its low (2.5%) lattice mismatch with copper. We evaporate nickel onto a (211) copper crystal and characterize film thickness and film composition. Our analysis of spectra shows copper Auger electron detection decreases as the nickel Auger electron contribution increases. We show that nickel grows on copper surfaces as layers and does not diffuse into the sample. The ability for nickel to form smooth, coherent films on copper will allow for future study on the magnetic properties of the films.

1:20 – 1:40PM **Cheryl-Ann Fujioka** and Ken Rines

Determining the Galaxy Luminosity Function for the Virgo Cluster

We measure the relative abundance of luminous and faint galaxies (the luminosity function or LF) as a function of galaxy environment. We use photometric and spectroscopic data from the Sloan Digital Sky Survey (SDSS) to identify galaxies in the core and the outskirts of the Virgo Cluster (the closest galaxy cluster). Extensive spectroscopy shows that Virgo members can be identified from their color indices and surface brightnesses. Previous SDSS data covered only the central 1 Megaparsec of Virgo; here we extend the analysis to the infall region where galaxies are bound to Virgo but have not yet passed through the dense cluster core. Thus, comparing the LF measured in the core and the outskirts is a powerful probe of the impact of galaxy environment on the abundance of faint galaxies.

1:40 – 2:00PM **Brian Svoboda** and Karin Oberg

Radial Distribution of Molecules and Ions in the Protoplanetary Disk Around IM Lup

We present spatially and spectroscopically resolved Submillimeter Array (SMA) observations of 12CO J=2-1, 13CO J=2-1, DCO+ J=3-2, N2H+ J=3-2, and H2CO J=4(14)-3(13) line emission from the IM Lup protoplanetary disk. We use Monte Carlo radiative transfer calculations to compare the SMA visibilities with tapered disk models, and use the results to constrain the outer radii of the emission regions. N2H+ and H2CO are proposed to trace dust grains at temperatures below 20 K, and DCO+ is proposed to trace gas temperatures below 40 K. The inferred outer radii for N2H+ and H2CO are both 600 AU, and 300-600 AU for DCO+. It is inconclusive from these results if the gas and dust is thermally decoupled in the outer disk.

2:00 – 2:20PM **Drew Grennell**, Trevor Croswell, and Andrew Boudreaux

Measuring Student Reflective Thinking in Intro Physics Labs

Many characteristics of expert learners have been studied and are well understood in cognitive and educational psychology, and more recently Physics Education Research (PER). However, teaching students strategies that will help them become more "expert-like" in their learning is not stressed in most traditional courses. In the intro, calculus-based physics labs at Western Washington University, students are introduced to metacognition, or "reflective thinking," through a scaffolded activity. In this study we examine student performance on this Reflective Thinking Activity (RTA) using video analysis and coding as primary tool of investigation. We find that even with guided questions and explicit prompting, most students fail to engage in even the most basic steps of reflective thinking. Also, based on the time evolution of lab groups over the span of ten weeks, we speculate that student framing of the activity can be correlated with their performance. This study serves primarily as a stepping-stone toward a more comprehensive analysis of students' reflective thinking, which includes video analysis, scanned classwork, survey data, and student interviews.

2:20 – 2:40PM **Brandon Owens** and Andreas Riemann

Molecular mechanics calculations of methionine on graphite surfaces

Methionine molecules can be used to create regularly spaced wires allowing for the use in both medicine and nanotechnology. Experiments have shown that the amino acid methionine self-assembles into equally spaced rows when deposited onto a graphite surface [1]. Using commercial modeling software like HyperChem®, molecular interactions can be described by different force fields using the molecule in ionic and zwitterionic configuration. Taking all of these parameters into consideration, the lowest energy configuration is found. Prior results using a single sheet of graphite, as the modeling substrate, yielded qualitatively good agreement with experimental results showing a dimer length of approximately 1.8 nm, hydrogen bond lengths of 0.2 nm and hydrogen bond energies close to 0.08 eV [1,2]. In order to acquire better qualitative agreement, the project was expanded to three additional substrate configurations. Results show that the modeling substrate has no effect on the dimer length, hydrogen bond length, and hydrogen bond energies. Future work lies in the exploration of other amino acids and the use of other force fields to test for closer experimental agreement.

[1]Riemann, A.; Nelson, B. Langmuir 2009, 25, 4522

[2]Riemann, A.; Owens, B. Surface Science 2010, 604, 2084

Break - Refreshments

2:40 – 3:00

3:00 – 3:20PM **Dylan Kloster**, K. Rines, B.E. Svoboda, R.L. Arnold, T.J. Welch, R.A. Finn, A. Vikhlinin
Optical Scaling Relations of X-ray Selected Clusters at Moderate Redshift

The relation between dark matter and galaxies is a fundamental problem in astrophysics. Here, we study this relation using optical observations of an X-ray-selected sample of clusters at moderate redshift (z=0.35-0.90). We collected griz images of 30 clusters with WIYN/OPTIC to measure the bright end of the luminosity function. Our imaging extends approximately 2 magnitudes fainter than M*, thus including most of the total cluster light. We use the red sequence and statistical background subtraction to estimate the richnesses and stellar luminosities of the clusters. We measure scaling relations by comparing the optical properties to X-ray mass estimates derived from Chandra observations. At low redshift, some studies indicate that total stellar luminosity is a better predictor of cluster mass than X-ray luminosity. We test whether a similar result holds at moderate redshift. In the future, we will compare the optical and X-ray properties to virial mass estimates from optical spectroscopy and to Sunyaev-Zeldovich Effect observations. If photometric properties of clusters are good predictors of cluster mass, these relations could be applied to large surveys like SPT, Planck, DES, eROSITA, and LSST to improve constraints on the properties of dark energy.

3:20 – 3:40PM **Rachel L. Arnold**, B. E. Svoboda, T. J. Welch, K. Rines, R. A. Finn, A. Vikhlinin
Evolution of galaxy cluster luminosity functions in the IRAC bands

We examine a sample of 41 galaxy clusters at moderate redshift ($0.35 \leq z \leq 0.90$) using images from the Spitzer Space Telescope's Infrared Array Camera (IRAC). After reducing the data with MOPEX and APEX software to generate clean, calibrated images, we use statistical background subtraction to determine the luminosity functions (a quantitative look at the light distribution) of the clusters. We then measure the dependence in the characteristic magnitude on redshift and cluster mass. These variations probe the integrated star formation history of the cluster galaxies. We match our catalogs to far-infrared MIPS catalogs. Four-color IRAC photometry of MIPS sources separates dusty star-forming galaxies from Active Galactic Nuclei (AGN). The combined data probe the evolution of both accretion onto supermassive black holes and the instantaneous star formation rates within cluster galaxies. This study represents the largest sample of moderate-redshift X-ray clusters observed with Spitzer to date.

3:40 – 4:00PM **Shane Peper** and Takele Seda

Ligand Assisted Synthesis and Characterization of Fe3O4 Magnetic Nanoparticles

Ligand assisted microemulsion method was used to synthesis nanomagnetic magnetite particles at different temperatures. Nanomagnetite particles synthesized without ligand show aggregation, hence magnetic signature at room temperature, an undesirable property for biomedical applications. Preliminary results of samples synthesized using ligand as a stabilizing agent, however, show promising properties. Mössbauer spectra of these particles show the presence of magnetic particles and some nonmagnetic particles. The presence of magnetic particles indicates that aggregation still persists. Synthesis using different molar ratios of the ligand to the sample is underway at different temperatures to overcome aggregation. In particular, these magnetic nanoparticles show remarkable new phenomena such as superparamagnetism after field cooling. This property is essential for applications in biomedicine where our particular research will prove to be significant in future work.

4:00 – 4:20PM **Trevor Morgan**, Jordan Marsh, Anthony Nault, Brad Johnson, Stephen McDowall, and Janelle Leger

Plasmon Polariton Modes in High Index Dielectric Structures

The need to interface optical signals with increasingly small electronic components has led to an interest in subwavelength waveguides. Waveguides based on the excitation of surface plasmon polaritons (SPPs) are promising for short-range applications. However, in these structures Ohmic damping significantly limits propagation length. High index dielectric plasmon polariton modes (HID-PPMs) are surface-constructed waves that exist in structures having a core dielectric layer with a higher refractive index than the glass substrate. Modes in this region exhibit oscillatory electric fields with the bulk of their electric field confined in the dielectric layer, similar to a total internal reflection (TIR) waveguide. Damping losses may therefore be drastically reduced in such structures. Unlike TIR waveguides, HID-PPMs can be excited along the full length of the waveguide, improving device versatility. Here we report the observation of HID-PPMs in Au/TiO2/Au structures using attenuated total reflection (ATR) measurements. Results are in close agreement with a theoretical model that is based on the general wave equation and appropriate boundary conditions. Waveguides based on HID-PPMs have the potential to improve a broad range of applications which rely on low loss energy transmission or compatibility with nanoscale components, such as telecommunications, optical signal processing, and solar concentration.

4:20 – 4:40PM **Amanda Norell Bader**, Anton Ilkevich, Ilya Kosilkin, and Janelle Leger

Precise Color Tuning via Hybrid Light-Emitting Electrochemical Cells

Quantum dots (QDs) are of much interest as the active emitter in a light-emitting device because of their size-tunable band-gap energies, allowing device color to be tuned over the entire spectrum by simply varying the size of QDs used. Additionally, colloidal QDs are compatible with low-cost solution processing techniques used to fabricate polymer light-emitting devices. QDs are also more stable and have higher photoluminescence efficiency than organic emitters, but their effectiveness when blended into a polymer LED structure is limited by a charge tunneling barrier caused by an insulating surface ligand layer. This often leads to significant unwanted emission from the polymer host material. Typically, hybrid QD-LEDs are constructed with a monolayer of QDs in order to overcome this limitation with moderate success. A light-emitting electrochemical cell (LEC) structure presents an alternative solution to this problem by limiting the thickness of the emissive region of the polymer/QD film. Emission spectra of QD-LECs employing two different sized CdSe/ZnS core-shell QDs blended into a single layer of a green-emitting PPV/PF copolymer show better color purity than polymer-only devices, with nearly pure emission from the QDs. Additionally, relative intensity of the two narrow QD emission peaks is precisely controlled by varying the mass ratio between the QDs. These results indicate the potential for excellent color tuning in a simple single-layer device. This device structure also has the potential to improve several issues currently limiting the performance of polymer-based optoelectronic devices, particularly in solid-state lighting.