Online Proceedings

Poster Session 1

Balcony, Easel 112

11:00 AM to 1:00 PM

SPAMS: The Search for Planets around Post-Main Sequence Stars

Katherine Grace (Katie) Reil, Sophomore, Pre-Health Sciences
Aislynn Wallach, Sophomore, Pre-Sciences
NASA Space Grant Scholar
Mentor: Brett Morris, Astronomy Department
Mentor: Eric Agol, Astronomy

When a star undergoes the transition to the white dwarf stage of the stellar life cycle, an outburst of ionized gas is expelled in a planetary nebula. It is currently unknown if planets orbiting a white dwarf are able to survive this transition. However, between one fourth and one half of white dwarfs have elements in their atmospheres that are heavier than helium and will sink into the white dwarf quickly unless they are somehow being replenished. The recent detection of a disintegrating rocky planet orbiting a polluted white dwarf suggests that the source of metal pollution may be debris from these bodies. As the Sun will become a white dwarf in the distant future, our team began the search for an intact planet, which could provide a model for examining the future of our own planet and solar system. Using observations from the ARCSAT 0.5 m telescope at Apache Point Observatory, we examined fluctuations in brightness of a small sample of white dwarfs, over a period of several nights. We visually inspected the white dwarf light curves for strong dips in brightness that could indicate the transit of a planet, and promising candidates were further analyzed via Lomb-Scargle Periodograms. Most of the white dwarfs displayed periodicities in flux, but none were indicative of the presence of a planetary body. Included in our data was an eclipsing binary white dwarf system with a known periodicity that our function could not detect correctly. We have improved our search by using the Box-Least Squares method to detect weak transits instead of periodograms, but have yet to detect an intact planet orbiting a white dwarf.

Poster Session 1

Balcony, Easel 116

11:00 AM to 1:00 PM

Modeling Kepler Eclipsing Binaries

Ananya Gupta (Ananya) Garg, Freshman, Gender, Women, and Sexuality Studies
UW Honors Program
Aleezah Ali, Freshman, Physics: Comprehensive Physics
Mentor: Diana Windemuth, Astronomy
Mentor: Eric Agol, Astronomy

Eclipsing binaries are systems in which two stars orbit and pass in front of each other. They are important astrophysical tools we utilize to measure fundamental properties of stars, such as their masses, radii, and temperatures. Here, we analyzed photometric data acquired from the Kepler satellite in order to model the light as a function of time of specific eclipsing binary systems. We selected these targets from the Villanova Kepler Eclipsing Binary Catalog. For each system, we used a least-squares optimization method to determine the best fit solution between the model and the observed light curve. Our light curve model has a total of 13 parameters. They include stellar elements such as sum of radii and flux ratio, as well as orbital elements such as period and eccentricity. In addition to providing orbital solutions, our models can be used to search for the presence of additional bodies in the system, such as a third star or a circumbinary planet.

Poster Session 1

Balcony, Easel 110

11:00 AM to 1:00 PM

Analysis of Apache Point Observatory 3.5m Enclosure Air Flow Efficiency

Courtney Nicole Johnson, Senior, Physics: Applied Physics, Astronomy
Mentor: Joseph Huehnerhoff, Astronomy

Airflow inside a telescope dome is crucial for the efficient collection of data. The purpose of this project is to analyze the airflow inside the dome of the 3.5 meter telescope at Apache Point Observatory. Air flow metrology was used to measure wind velocity at multiple points in the dome over several months. This data was reduced using numerical computation. With this data, analysis was performed for trends both computationally and using 3D visualization of vector flow patterns. This data will be used to improve the dome airflow by moving and replacing louvers throughout the dome. By doing so, the wind flow across the telescope light path will be optimized and the resolution of targets at this telescope will be improved.

POSTER SESSION 1

Balcony, Easel 109

11:00 AM to 1:00 PM

Manastash Ridge Observatory Software Architecture Upgrade

Tristan J (Tristan) Hillis, Fifth Year, Physics: Comprehensive Physics
Douglas Robert (Doug) Branton, Senior, Physics: Comprehensive Physics, Astronomy
Mentor: Joseph Huehnerhoff, Astronomy

The University of Washington's Manastash Ridge Observatory is being upgraded with a telescope auto-guiding system and a replacement camera, funded by Student Technology Fund. The new, in-house, upgrades call for a high-level software implementation from the ground up. Utilizing the programming language Python, we build two graphic user interfaces (GUIs) for controlling the telescope and camera independently. With a telescope control GUI, we supply the basic features to drive the telescope, while also ushering in the controls for the auto-guider, greatly enhancing the past capability. Meanwhile, the camera GUI handles the different camera exposure settings, camera filters, and saving of images. We construct the GUIs using the software package wxPython in conjunction with the package TwistedPython. In tandem, these software comprise of the bulk underlining functionality; where we use the feature set of wxPython to receive top-level client input and then talk to our hardware systems with TwistedPython to convey the user's needs. Ultimately, the move to completely new, high-level software allows us more control than proprietary solutions allowing us to implement an intuitive end-user experience that will run on any computer towards the future.

POSTER SESSION 1

Balcony, Easel 111

11:00 AM to 1:00 PM

Instumentation Upgrades at Manastash Ridge Observatory

Kyle Andrew (Kyle) Olinger, Senior, Astronomy, Physics: Comprehensive Physics
Joshua Elliott Oppor, Senior, Astronomy, Physics: Comprehensive Physics
Mentor: Joseph Huehnerhoff, Astronomy

The Astronomy Undergraduate Engineering Group's (AUEG) is designing and installing a new instrument multiplexer for the 0.76m telescope at the Manastash Ridge Observatory (MRO). The multiplexer includes mechanics for the focal reducing optics, guider, filter wheel, the Student Technology Fee (STF) funded high performance photometer, as well as the STF funded spectrograph. Most of the research effort is going into the quick-change, fiber fed spectrograph that will extend our capabilities into new areas of astronomical observations. This instrument will be capable of switching between imaging and spectroscopic observations within seconds, all while maintaining an on-sky lock on the target. It will also include several resolution modes allowing for a varied ability for the user to choose between high throughput and high resolution. Through the efforts of the AUEG and the funding by the STF and MRO will once again have a full suite of high performance instrumentation with the ability to take several minute exposures, both photometrically and spectroscopically. Expected final product completion date for the instrumentation upgrades is Fall 2016.

POSTER SESSION 1

Balcony, Easel 113

11:00 AM to 1:00 PM

Effects of Supermassive Black Hole on Host Galaxy Properties

Zoe Rose (Zoe) Deford, Freshman, Physics: Comprehensive Physics
Joshua J. Smith, Sophomore, Pre-Health Sciences
Mentor: Thomas Quinn, Astronomy
Mentor: Michael Tremmel, Astronomy

Little is understood about how Supermassive black holes affect their host galaxies in terms of growth and shape. Using the Simulation Romulus25, we are able to study how galaxy properties correlate with black hole properties throughout time. The simulation is a cube with lengths of 25 Mpc on each side, which is about 75 million ly or 21000 Milky way galaxies. We look at how the properties of galaxies relate to the properties of their black holes. We present trends that distinguish star forming galaxies from quenched galaxies.

POSTER SESSION 1

Balcony, Easel 115

11:00 AM to 1:00 PM

Examining the X-ray Luminosity Function of NGC 300 with the Chandra X-ray Observatory

Jacob Alexander Gross, Senior, Physics: Comprehensive Physics
Undergraduate Research Conference Travel Awardee
Mentor: Benjamin Williams, Astronomy
Mentor: Breanna Binder, Astronomy

We have obtained three epochs of observations of the nearby spiral galaxy, NGC 300, using the Chandra X-ray Observa-

tory. Using this data, we searched for variability in the X-ray luminosity function (XLF) of NGC 300's X-ray point source population. When the entire X-ray source population was considered, the XLFs were best described by using a power law with a slope of ˜0.6-0.7. However, the XLFs of intrinsically variable X-ray sources showed significant variability between observations, especially at low luminosities (< 10ˆ37 erg/s). We created synthetic, variable X-ray sources to probe the characteristics of the X-ray point source population in NGC 300. In order to match the observations, our models required that the peak X-ray luminosity of variable sources are significantly lower than commonly assumed, which is characteristic of a mass transfer due to direct wind accretion at significantly sub-Eddington rates.

POSTER SESSION 1

Balcony, Easel 108

11:00 AM to 1:00 PM

Manastash Ridge Observatory Offset Guider

Adrian Luis (Adrian) Davila, Senior, Astronomy, Physics: Applied Physics
Jakob Balkenhohl, Junior, Exchange - Arts & Sciences
Jason Andrew Lozo, Graduate, Engineering (Mechanical Engineering)
Mentor: Joseph Huehnerhoff, Astronomy

The Astronomy Undergraduate Engineering Group is building an attachment to improve the science capabilities of the Manastash Ridge Observatory 30 inch telescope. This attachment is an offset guider which will improve tracking capabilities allowing the telescope to stay within two arcseconds of a target star (seeing limit) for an extended period of time. The guider uses unused light from the main optical path that is reflected off with a pick-off mirror onto a detector. A rotating periscope design is used to take full advantage of all of the unused light by creating a simulated large field that the detector can use to increase the sampling area. The periscopes rotational position along this field will be driven by a high precision stepper motor for maximum control. Two linear actuators will als o be used to check the primary focus of the telescope so that it may dynamically correct for any wandering of the focus.

POSTER SESSION 1

Balcony, Easel 114

11:00 AM to 1:00 PM

The Meridian Line of the *Basilica di Santa Maria degli Angeli e Martiri*

Guadalupe (Lupita) Tovar, Senior, Astronomy
NASA Space Grant Scholar
Jennifer W. (Jennifer) Look, Senior, Biology (General), Comparative History of Ideas
Mary Gates Scholar, CoMotion Mary Gates Innovation Scholar
Mallory Douglas Thorp, Senior, Astronomy, Physics: Comprehensive Physics
Mentor: Woodruff Sullivan, Astronomy

Initially designed by Michelangelo, Santa Maria degli Angeli e Martiri is a Roman Basilica built atop the ruins of the Baths of Diocletian and represents a collaborative relationship between science and religion. The famous meridian line that extends throughout the church was constructed by Francesco Bianchini in order to validate the Gregorian calendar and more specifically, predict the date of Easter. Meridian lines are a variation of a sundial; a hole in the wall of the church that allows an image of the sun to transit the meridian line on the floor. The location of the image corresponds to a particular day of the year, calculated by Bianchini using the geometry of the hole's placement. Additionally, a second hole in the wall allows light from the North Star to follow a pattern of ellipses at one end of the meridian line and traces the expected long-term path of the star. During a UW study abroad trip under joint-guidance of the Astronomy and Art History departments during Spring quarter 2015, students were able to take physical measurements of the meridian line. Using videos and images of noon solar transit, the accuracy of the meridian line was calculated with respect to predictive models in astronomy, with emphasis on the historical contexts of religion and art. Our inquiry includes quantitative analysis of changes in precession of Polaris, declination of the sun, and obliquity of the ecliptic, over several centuries. Ultimately, this project intends to investigate how the meridian line can provide an insight regarding the longevity and accuracy of scientific models as well as acknowledge the implications of scientific discourse on society, art, and religion.

SESSION 2O

ASTRONOMY

Session Moderator: Suzanne Hawley, Astronomy

JHN 026

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Testing Our Models for the Stuff Between Galaxies

Bayu Jarod Wilson, Freshman, Physics: Comprehensive Physics
Adriana Cristina (Adriana) Gomez Buckley, Freshman, Physics: Comprehensive Physics
Mentor: Phoebe Upton Sanderbeck, Astronomy
Mentor: Matthew McQuinn, Astronomy

The models of the universe's diffuse configuration of hydrogen and helium atoms, known as the Intergalactic Medium (IGM), have become increasingly accurate in predicting the mechanics of the universe. Simulations of the IGM can provide a foundation for cosmology to be built upon. The purpose of our research is to test the accuracy and precision of our latest model of the IGM. Using data from the Very Large Telescope (VLT) in Chile, we analyzed quasar spectra for absorption lines at the Lyman-Alpha wavelength, creating phenomena called the Lyman-Alpha forest. We then processed this data incorporating scripts written in the programming language, Python, in order to compare the probability distribution function of the Lyman-Alpha absorption of the observed quasar spectra to the simulated quasar spectra. Interpreting our data we found that our simulations fell within one standard deviation of the observed data. Further analysis of our data showed that the simulations were more accurate for quasars at a lower redshift - those which were moving away from us at a slower rate - than quasars at a higher redshift - those moving away from us most rapidly. The largest contributors to error stem from the effects of other material in the IGM causing metal lines, our methods of metal line removal, and the limits of the size and quality of our observational sample. Metal lines skew our understanding of the Lyman-Alpha forest and a larger sample would decrease the variance among the samples. We plan on continuing research and improving the techniques of comparing the observations to models. An increased understanding of an effective model of the IGM can be used as a cosmological map of time to predict the origins of the universe as well as its future.

SESSION 2O

ASTRONOMY

Session Moderator: Suzanne Hawley, Astronomy
JHN 026
3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Feasibility of Exomoon Detection and Spectral Recovery in the Presence of Exozodiacal Dust

Tiffany Channelle (Tiffany) Jansen, Senior, Astronomy, Physics: Comprehensive Physics
NASA Space Grant Scholar, Undergraduate Research Conference Travel Awardee, Washington Research Foundation Fellow
Mentor: Eric Agol, Astronomy

Although roughly two thousand exoplanets have been discovered and confirmed to date, exomoons have yet to be detected orbiting these planets. The detection of an exomoon would give insight into planetary formation and possibly increase the habitable real estate in a planetary system. Current telescopes are not capable of spatially resolving an exoplanet and its exomoon, or of separating the two blended spectra in a combined light measurement. However, previous work has shown that there is a wavelength dependent photometric centroid shift between a planet and its moon due to the weighted nature of the center of light (Agol et al. 2015). This spectroastrometric shift is highest in bands where the planet is dim and the moon is relatively bright, which can happen if it differs compositionally from its planet. As part of the "Finding the Needles in the Haystacks" project, we generated a realistic spatial / spectral model of an Earth-like exomoon orbiting a warm Jupiter in the habitable zone of a Sun-like star, including plausible exozodiacal dust structure. Preliminary results show that the presence of an Earth-like exomoon can produce centroid shifts greater than a milliarcsecond at some wavelengths, enabling the detection of the Earth-like exomoon even in the presence of dust. However, extracting the spectrum of the Earth-like exomoon has proved to be challenging, even when employing a simple telescope simulation devoid of coronagraphic effects, and further work will be needed to determine if it is possible even with 12-meter-class space telescopes.

SESSION 2O

ASTRONOMY

Session Moderator: Suzanne Hawley, Astronomy
JHN 026
3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Cataclysmic Pulses: Investigating Temperature Instability of Accreting White Dwarf Pulsators

Donald Francisco (Donald) Serna Grey, Senior, Astronomy, Physics: Comprehensive Physics
NASA Space Grant Scholar
Mentor: Paula Szkody, Astronomy

The compact core that remains after a star like our Sun dies is called a white dwarf. Some of these stars have close orbiting companion stars that they will accrete matter from constantly. This accretion eventually causes outburst events called dwarf novae. These binary star systems are known as cataclysmic variables. The six telescope observing targets for this project also undergo variable brightness pulsations due to temperature instabilities in the near pure hydrogen atmpspheres of these white dwarf stars. These variable brightness pulsations make these stars ZZ Ceti pulsators in addition to being cataclysmic variables. We present time series photometry in the optical range from cataclysmic variable white dwarf ZZ Ceti pulsators as part of an ongoing long term investigation of accretion dynamics and white dwarf internal structure. These light curves are used in comparison with UV light curves gathered from the Hubble Space Telescope to probe the temperature and pulsation properties of these targets. Previous observations suggest a temperature instability strip that is broader than current models predict. This investigation will empirically measure the instability strip as our pulsator telescope targets cool and restart regular pulsations after dwarf nova outburst events that were observed near the start of this project. Measurements of the time it takes the pulsations to reappear allows for an estimation of accreted mass and heating that occurred during the dwarf nova outburst. These measurements have confirmed the target SDSS0755+14 as a ZZ Ceti pulsator in the target pool and allow for tighter constraints and refined models of binary and accretion interactions of white dwarf systems, especially Type Ia supernova progenitor models.

SESSION 2O

ASTRONOMY

Session Moderator: Suzanne Hawley, Astronomy
JHN 026
3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

The Radioactive Habitable Zone

Benjamin Dean (Ben) Guyer, Senior, Physics: Comprehensive Physics, Astronomy
Mentor: Rory Barnes, Astronomy

With the first detection of an exoplanet in the 1990's, the goal of discovering life beyond our solar system became a real possibility. Since then, thousands of exoplanets have been discovered, many of which are Earth-sized and potentially habitable. The planned James Webb Space Telescope may be capable of taking spectra of the atmospheres of Earth like exoplanets to determine if life is present. However, technical constraints will limit the number of targets to only a few within its operational lifetime. Prioritizing targets based on their potential to support life is therefore essential. Here, we study one crucial, but often overlooked, factor in determining habitability – the internal thermal evolution of exoplanets. A planet that is too cold may lack geochemical cycles, such as the carbon cycle on Earth, that maintain a stable atmosphere. A planet that is too hot may be too volcanic to support life. In between lies a "habitable zone" of internal energy. To search for its limits, we use computer models to simulate the thermal evolution of planets as a function of two factors – abundance of radioactive elements, and initial internal temperature. Radioactive decay provides a modest but steady source of energy for planets, while events like the impact that formed our moon can deposit enormous amounts of energy but on a much shorter time scale. The results of our analysis suggest that a given planet's thermal evolution is far more sensitive to the abundance of radioactive elements than its initial temperature. For example, Earth without radioactivity would have become tectonically dormant in only 3 billion years. But with levels of radioactive isotopes like those in carbonaceous chrondrite meteorites, Earth could have experienced Io-like levels of volcanism for the first billion years.

SESSION 2O

ASTRONOMY

Session Moderator: Suzanne Hawley, Astronomy
JHN 026
3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Finding the Rotation-Activity Relation in a Spectroscopic Survey of Kepler M Dwarfs

Tessa D. (Tessa) Wilkinson, Senior, Astronomy, Physics: Comprehensive Physics
Mary Gates Scholar, UW Honors Program, Undergraduate Research Conference Travel Awardee
Mentor: Suzanne Hawley, Astronomy

Main sequence stars that are 20-50% the mass of the sun and have a cooler surface temperature of less than 4000 Kelvin making them appear red are classified as spectral type M. These low mass M dwarf stars are the most common type of star in the Galaxy and often exhibit strong magnetic fields and magnetic activity including chromospheric emission and flares. We are investigating how this activity is correlated with the rotation period and metallicity of the star. A dataset of a few thousand M dwarfs with measured rotational periods monitored by the Kepler spacecraft is now available to investigate these possible correlations. We obtained followup spectroscopic data from the ARC 3.5 meter telescope at Apache Point Observatory (APO), and report the spectral types and metallicities of nearly 100 Kepler field M dwarfs with measured rotational periods. Previous studies utilize the Kepler Input Catalog (KIC) for estimates of spectral type and temperature that are based on multi-band photometry. Our independent spectral measurements are crucial to improve on these parameters as the KIC measurements are known to be unreliable for low mass stars. Using reduced spectra from the APO/3.5m Dual Imaging Spectrograph (DIS) high resolution mode (R˜5000) we measured the magnetic activity through the chromospheric emission from the Hydrogen Balmer-alpha emission line. Metallicity measurements were obtained from DIS low resolution mode spectra (R˜1000) via comparison to M dwarf calibration stars with known metallicities. We present our results including the magnetic activity correlation with rotation and metallicity at different M subtypes, and discuss the implications of these data for low mass star evolution.

SESSION 2O

ASTRONOMY

Session Moderator: Suzanne Hawley, Astronomy

JHN 026

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Observatory Cloud Monitoring System

Matt Armstrong, Senior, Astronomy, Physics: Comprehensive Physics
Mary Gates Scholar
Andrew James (Andrew) Wilkins, Senior, Astronomy, Physics: Applied Physics
Mentor: Joseph Huehnerhoff, Astronomy

The purpose of this research is to design, build, and deploy an all-sky cloud monitor instrument for Apache Point Observatory. This camera will be used to monitor the sky surrounding the telescope and provide sight down to the horizon via visual and numerical feedback. This research will create automatic image analysis software that will calculate sky brightness and uniformity, both of which can be used to constrain the level of atmospheric blockage. The cloud camera system will also have weather metrology feedback which can alert observers using the telescopes to current hazardous weather conditions. As a self-contained unit, this camera, and associated sensors, will require no actions by on-site or remote observers to function. An instrument with this mode of operation will allow for safe remote observing with minimal (to zero) engineering support. The end users of this instrument will be astronomers using the telescopes remotely. This will allow remote users to see the current sky conditions, which can have a great effect on their data.

POSTER SESSION 4

Commons East, Easel 46

4:00 PM to 6:00 PM

Understanding the Host Galaxies of Supermassive Black Hole Mergers

Daniel Robert (Daniel) Simons, Junior, Physics: Comprehensive Physics, Astronomy
Daven M. (D) Cocroft, Senior, Physics: Comprehensive Physics, Psychology, Astronomy
Mentor: Fabio Governato, Astronomy
Mentor: Michael Tremmel, Astronomy

We determine when and in what galaxies Supermassive Black Hole mergers occur and what they tell us about galaxy evolution throughout the history of the universe. We are doing this through analyzing ROMULUS25, which is a simulation–the size of a box that is 80 Million Light Years per side–of the universe from the big bang to the present day. The data from ROMULUS25 includes the evolution of thousands of galaxies and is able to resolve the internal structure of galaxies. We use the programming language python to sift through all of the data in our simulation in order to determine the rate at which Supermassive Black Holes merger together, and what the different conditions are before and after the merger. Our preliminary results suggest that the closer the ratio of masses of the two Supermassive Black Holes are will result in a much lower merger rate. This will help us understand the coevolution of galaxies and Supermassive Black Holes and allow us to predict and contextualize future observations of gravitiational waves from the LISA mission, which is a space-based gravitational wave detector.