Online Proceedings

POSTER SESSION 2

Balcony, Easel 103

12:45 PM to 2:15 PM

Astronomy for the Visually Impaired

Margaret Morrison (Meg) Wilson, Sophomore, Earth and Space Sciences: Geology
Mentor: Sarah Loebman, Astronomy
Mentor: Ana Larson, Astronomy

We present an extension of the Astronomy Department's curriculum for visually impaired junior high school students. Our lesson plans are a complementary addition to Noreen Grice's Braille and large print readings. These lessons satisfy the Washington State Essential Academic Learning Requirements (EALR's) for junior high school students, the level at which students are introduced to astronomy. We present here a sample of new material that covers the composition, formation and evolution of the Sun. Our lessons include activities, audio tracks, 3D models, and online links to advanced topics. We outline additional curricula that we are actively developing, such as biographies of visually impaired astronomers and topics including the formation and evolution of the Solar System's terrestrial planets. We will test our curricula during this coming school year, as we did in 2007, at the Washington State School for the Blind, with the expectation of deeply strengthening the students' understanding of the evolution of the Sun beyond what is available in their textbooks. Ultimately, this curricula will be distributed and utilized throughout the United States as part of the on-going national and international efforts to promote astronomy for those who are visually impaired. We conclude with a description of our role in building and testing additional educational tools.

POSTER SESSION 2

Balcony, Easel 98

12:45 PM to 2:15 PM

Measuring Masses and Radii of the Young Star System MML53

Anthony Matthew (Anthony) Paat, Senior, Astronomy, Physics
Mentor: Leslie Hebb, Astronomy

MML 53 is a system of young stars which, in 2010, was discovered to be an eclipsing binary. A detailed analysis of the brightness changes and velocity variations of an eclipsing binary provides precise measurements of the masses, radii, temperatures, and luminosities of two stars with the same age and chemical composition. Thus, eclipsing binary stars are extremely important astronomical systems that are used to test our understanding of the structure and evolution of stars. Despite their importance, young eclipsing binaries, like MML 53, are rare. We applied the PHOEBE (Physics of Eclipsing Binaries) software to the observed multi-wavelength time series photometry data of MML 53 to derive precise values for the combined radii of the two stars, the effective temperature of the secondary star, and reasonable locations for the starspots on both the primary and secondary stars. Using a Markov chain Monte Carlo analysis (eMCMC Hammer) we ran over 60000 PHOEBE models which has allowed us to explore correlations between various parameters and derive realistic uncertainties on the final fundamental properties of these two young stars.

POSTER SESSION 2

Balcony, Easel 97

12:45 PM to 2:15 PM

Observing Stellar Flares on M Dwarf Stars

Tiffany Channelle (Tiffany) Jansen, Freshman, Pre-Sciences
Andrew Paul Hillman, Sophomore, Pre-Sciences
Mentor: Suzanne Hawley, Astronomy
Mentor: James Davenport, Physics & Astronomy, Western Washington University

M dwarf stars are classified by their small radii and relatively cool surface temperatures. Their internal structures are known to be almost entirely convective, and this extreme convection causes a tangling of the stars' magnetic field lines. Upon realignment of the magnetic field lines, an incredible amount of energy is released from the star in what is called a flare. This research project is an ongoing observation of the flare activity on the M dwarf stars GJ1243 and GJ1245. Two months of flare activity was observed using the flux measurements made by NASA's Kepler telescope. The frequency, duration and types of flares were recorded and analyzed with the aid of the computer program "Flares by Eye." It has been observed that most flares have short rise times and long decay times, the intensities of which seem to follow a power law. Continued research on this topic will help us learn more

about the physics behind the ignition of these stellar explosions, how the flares decay, and how the stars become less active as they age.

SESSION 2S

ASTRONOMY AND PHYSICS

Session Moderator: Suzanne Hawley, Astronomy
026 JHN
3:45 PM to 5:15 PM
* Note: Titles in order of presentation.

Detection of Transiting Exoplanets using Kepler Lightcurves
John Mark (John) Mehlhaff, Junior, Computer Science, Physics: Comprehensive Physics
NASA Space Grant Scholar
Nancy Helen (Nancy) Thomas, Senior, Astronomy, Physics
Mary Gates Scholar, NASA Space Grant Scholar, Undergraduate Research Conference Travel Awardee, UW Honors Program
Christopher James Martin, Senior, Astronomy, Physics
Mentor: Eric Agol, Astronomy
Mentor: Andrew Becker, Astronomy
Mentor: Benjamin Vega-Westhoff, Astronomy

Exoplanets are planets outside our solar system, and the current explosion in exoplanet discoveries is revolutionizing our understanding of the potential for extraterrestrial life. This prolific era of detections has stemmed largely from the unprecedented observing capabilities of NASA's Kepler Space Telescope. The Kepler Spacecraft collects high precision time-series photometric data on a fixed group of approximately 160,000 stars. The data are represented by temporal lightcurves (i.e. brightness vs. time) that can be used to detect transiting exoplanets, the topic of our research. Transits are events where an orbiting planet partially eclipses its host star, casting a small shadow on the telescope. To detect transit signals, we rely on the Quasi-Periodic Automated Transit Search Algorithm (QATS). As an automated tool, QATS provides a crucial means to reduce the Kepler dataset to a manageable size. However, since the algorithm is sensitive to stellar variability, eclipsing binary stars, and systematic artifacts of the spacecraft, additional analysis is required to separate true detections from false positives. Determining the best way to do this is the present focus of our work. Concurrently, we are exploring the potential for QATS not only to determine orbital period, but also to constrain transit depth and duration (properties related to the size of the exoplanet and to the density of the stellar host). While this increases the complexity of the QATS algorithm and the amount of output to manage, it provides greater potential for a fully automated transit search process with results that are more descriptive of the exoplanet systems detected.

SESSION 2S

ASTRONOMY AND PHYSICS

Session Moderator: Suzanne Hawley, Astronomy
026 JHN
3:45 PM to 5:15 PM
* Note: Titles in order of presentation.

Satellite Galaxies as Dynamical Tracers for NGC 2841
Denise Marie (Denise) Schmitz, Senior, Mathematics (Comprehensive), Physics: Comprehensive Physics, Astronomy
Mary Gates Scholar
Mentor: Peter Yoachim, Astronomy

Research on galaxy dynamics indicates that visible matter cannot account for all of a galaxy's mass; the prevailing theory is that each galaxy is surrounded by a halo of dark matter. Dark matter can be studied by observing its gravitational influence on luminous matter, a technique known as dynamical tracing. We measure the orbital velocities of dwarf satellite galaxies as dynamical tracers for a central galaxy. Using data from the Sloan Digital Sky Survey (SDSS) DR8 and HyperLeda databases we have identified massive, isolated galaxies as potential targets and selected NGC 2841, a nearby large spiral galaxy. We also used SDSS to identify potential satellite galaxies and prioritize them for observation. Using the DIS spectrograph on the Apache Point Observatory 3.5m telescope, we have performed optical spectrosopy on a number of satellites to determine their line-of-sight velocities. We will use these results and a Jeans equation approximation to infer the mass of NGC 2841, and by comparing this value to the amount of visible mass, we will estimate the mass of its dark matter halo.

SESSION 2S

ASTRONOMY AND PHYSICS

Session Moderator: Suzanne Hawley, Astronomy
026 JHN
3:45 PM to 5:15 PM
* Note: Titles in order of presentation.

Revising the Properties of Low-Mass Stars to Better Determine the Habitability of Their Planets
Justin Brenton, Senior, Physics: Comprehensive Physics, Astronomy
Mary Gates Scholar
Mentor: Sarah Ballard, Astronomy

Extrasolar planets are being discovered at an incredible rate today. We have yet to discover another planet that can support life as we know it, but that will very likely change soon. Currently, most exoplanets are discovered indirectly by the influence they have on their host stars. Therefore, we only know the temperature and size of an exoplanet as well as we know the temperature and size of the star it orbits. For low-mass stars in the spectral range between K5 and M2, models do not provide the desired accuracy for these parameters. I improve this accuracy for a sample of planet candidates discovered by the Kepler Space Telescope by using a technique that assigns the parameters of nearby and well studied "stellar twins" to the planet hosting stars. I find these stellar twins by comparing the spectra of planet hosting stars to the spectra of similar nearby stars. By assigning the parameters of the nearby stellar twins to the planet hosting stars, I reduce the uncertainties in size and temperature for the planet hosting stars. This will also reduce the uncertainties in the size and temperature of the exoplanets, and thus allow for a better determination of their habitability.

POSTER SESSION 3

Commons West, Easel 21

2:30 PM to 4:00 PM

University of Washington Mobile Planetarium: Bringing HST Science to Seattle Public Schools

Justin D (Justin) Gailey, Senior, Astronomy, Physics
Undergraduate Research Conference Travel Awardee
Mentor: Oliver Fraser, Astronomy
Mentor: Philip Rosenfield, Astronomy

Digital planetariums and their software are revolutionizing what can be visualized and hence raising the educational impact to K-12 students and the general public. The ability planetariums offer to present and visualize cutting-edge research of star, planet, and galaxy formation and evolution, in 3-dimensions, has unlocked new discovery space in educators' ability to communicate and teach science. In order to improve the UW Astronomy department's public outreach programs as well as lay out a model for other Universities and astronomy outreach groups to follow, we assembled a mobile planetarium using new cost-saving methods and have begun designing an innovative curriculum to best implement digital planetariums in high school classrooms. To accomplish this, we used an HST education and public outreach grant (EO-12512) to build the planetarium as well as offset transportation costs to the UW planetarium. The UW mobile Planetarium was developed for less than $18,000, and allows us to increase the number of underserved elementary and high school students the UW Astronomy department reaches. We are beginning to test and evaluate the efficacy of teaching using the mobile planetarium in a high school setting. The mobile nature of the planetarium allows us to develop interesting inquiry-based lessons that incorporate WWT tours.

POSTER SESSION 3

Balcony, Easel 109

2:30 PM to 4:00 PM

An Exploration of Binary Stars

Adrian Luis (Adrian) Davila, Freshman, Astronomy, Physics: Comprehensive Physics
Cameron Mitchell Harmon, Freshman, Pre-Sciences
Mentor: Eric Agol, Astronomy
Mentor: Brian Lee, Astronomy

Binary star systems offer a deeper insight in regards to the properties of the stars in those systems, as opposed to the observation of a single star. Information from binary stars can help to better understand the lifecycle of stars, the interation among stars, and more accurate predictions as to the mass and radius of certain stars. This study analyzed the radial velocity and lightcurve data from eight binary star systems. Data were collected from the Kepler Space Telescope MAST database. A variety of IDL routines were used in analyzing the lightcurve data. When looking at the lightcurve data we were able to make a breakdown of the curves, determining what portions of light were contributed by Doppler beaming, ellipsoidal deformation and reflection off of the stars. These IDL routines are essentially bits of code used to analyze the data in a systematic manner. We were also able to make rough estimates of the masses and radii of some of the stars using simplified versions of Doppler beaming equations. From the results we were able to identify heartbeat star systems, eclipsing and non-eclipsing binary star systems as well as the periods of the orbits of these systems. Starspots proved to make the interpretation of lightcurves more difficult as they introduced inconsistent changes into the lightcurve data by showing a decrease in magnitude as if from an ecclipsing object but instead from the starspot itself. Future work includes resolving more accurate radii and masses by taking into account the inclination of the orbits by looking more in depth at the radial velocities.

POSTER SESSION 4

Balcony, Easel 88

4:15 PM to 5:45 PM

Discovering the Inner Oort Cloud

Jesse Velasquez, Senior, Astronomy, Physics: Comprehensive Physics
NASA Space Grant Scholar
Mentor: Thomas Quinn, Astronomy

The discovery of 2003 VB12, or "Sedna", far beyond Pluto has suggested a new class of Solar System objects. These objects are not members of the Kuiper belt, a large disk of icy objects spanning roughly 30 AU to 50 AU from the sun; nor do they reach far enough to be considered members of the Classical Oort Cloud, which is comprised of Long Period Comets (LPCs) and distant objects that may take millions of years to orbit the sun. Both of these groups and this new class of objects are likely debris from the planets' formation, making them surviving "fossils" from the Solar System's early history that can be directly examined. Despite the great numbers of this population, however, the vast majority is undetectably dim, a problem that observers hope to address by peering deeper than ever with the upcoming Large Synoptic Survey Telescope (LSST). Sedna-class objects may be unique in that they provide clues about the Solar System's interaction with the Galaxy over its history. Because they orbit beyond the boundaries of planetary perturbations, they could have resulted from the sun's migration close to the galactic center. I, along with Alexia Lewis, ran simulations of the Solar System's formation with this migration model. I then analyzed them alongside "static" model simulations, which could be compared to past survey data and be used to predict the numbers of comets and Sedna-like objects that will be seen by the LSST. Later verification by the LSST will constrain models of the inner Oort cloud (where LPCs are expected to be abundant) and the region of Sedna-like objects, provide exciting new clues toward our models of how the Solar System was formed, and whether it has migrated from the center of the Galaxy over its history.

Poster Session 4

Balcony, Easel 89

4:15 PM to 5:45 PM

Impact of Black Holes in Cosmological Simulations of Galaxy Clusters

Taylor Montana (Taylor) Posey, Junior, Extended Pre-Major
Brianna Louise Diaz, Sophomore, Pre-Sciences
Mentor: John Ruan, Astronomy
Mentor: Breanna Binder, Astronomy
Mentor: Philip Rosenfield, Astronomy
Mentor: Eric Agol, Astronomy

Observations suggest that the intracluster medium in galaxy clusters is strongly influenced by supermassive black holes residing in cluster centers. We investigate the consequences a black hole can have on the thermodynamics of the gas in galaxy clusters by comparing the properties of a simulated galaxy cluster without black holes to X-ray observations of real clusters, which have black holes. For our data we used Python to manipulate a cosmological simulation made with ChaNGa, a code capable of simulating gravity, thermodynamics, and other things. Our cluster simulation includes gravity, hydrodynamics, gas cooling, star formation, and stellar feedback in a fully cosmological setting. However, this simulation lacks black hole formation, growth, and feedback, allowing us to pinpoint the effects of these processes on the cluster by comparing to observations. In our investigation, we found only minor differences in the density, temperature, and pressures of the gas between the observed and simulated galaxy clusters in the cluster outskirts. However, we found significant deviations between the simulation and observations near the cluster centers, where a large spike in star formation is present in the simulated cluster, not seen in the observations. Our results suggest that black hole formation and feedback in galaxy clusters most strongly affect the cluster in the central regions, where it can significantly decrease star formation by heating the gas.

Poster Session 4

Balcony, Easel 102

4:15 PM to 5:45 PM

Determining Star Formation in Red Spiral Galaxies

Meagan Briana Joyce (Meagan) Albright, Senior, Astronomy, Physics
Mentor: Peter Yoachim, Astronomy

Through the Galaxy Zoo Project, a project that lets public volunteers classify galaxies taken by numerous telescopes, several spiral galaxies were found that appear to be red in color in the visible wavelengths. Typically, only elliptical galaxies are red, so finding spiral galaxies of this color is an oddity. Initial analysis and explanations of these objects claimed that this group of galaxies has no star formation. However, these galaxies seem to be emitting massive amounts of light in the ultraviolet (UV), which might indicate that star formation is actually occurring. For this project, we compared the radial fits of these objects in the optical and ultraviolet using data from GALEX (Galaxy Evolution Explorer) and the SDSS (Sloan Digital Sky Survey) to see if these objects are just regular high mass spirals or galaxies nearing the end of their star formation that have exhausted their gas supply. Preliminary results show that the galaxies are slightly brighter near their center in the optical compared to the UV, but in the disk of the galaxies, the UV images are brighter than the optical images. This could mean that these galaxies indeed have star formation occurring in them.