GRAM
GEORGIA REGIONAL ASTRONOMY MEETING 2022

Georgia Regional Astronomy Meeting
November 5, 2022

Mercer University

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DEPARTMENT OF PHYSICS

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Georgia Regional Astronomy Meeting November 5, 2022 Mercer University

8:30 Breakfast

Talks

9:00 AM- *James Webb Space Telescope: Overview and Plans for Cosmic Dust Studies*

Varsha Kulkarni, University of South Carolina

The James Webb Space Telescope (JWST), launched on Dec. 25, 2021, is the successor to the Hubble Space Telescope (HST). The JWST is designed to observe primarily in the infrared, and is far more powerful than HST or other past space telescopes for observations of a variety of astronomical objects, such as extrasolar planets and very distant galaxies. We have been awarded observing time with the JWST's mid-infrared instrument to study interstellar dust grains in distant galaxies. I will review some of the unique features of the JWST, its benefits over the HST, its deployment, and the first science images. I will also describe our planned observations of distant dusty galaxies with JWST, and the motivations for these studies to understand the impact of dust on the physics and chemistry of the interstellar medium and the appearance of the distant universe.

9:40 AM- *Wave Reflection in the Solar Atmosphere*

Varun M. Chaturmutha, Stuart M. Jefferies, Bernhard G. Fleck, Georgia State University

Acoustic wave reflection in the solar atmosphere can provide insights into atmospheric heating, chromospheric resonances, and the height of the plasma $\beta=1$ surface. We present strong evidence of wave reflection in the solar atmosphere through helioseismic analysis of multi-height Doppler data. This evidence is provided through our newly developed phase dispersion model that incorporates downward traveling (reflected) waves in addition to upward traveling waves. Furthermore, using this new model, we present variations of the acoustic cutoff frequency, radiative damping time, and the reflection coefficient with the magnetic field strengths. The acoustic cutoff frequency is sensitive to magnetic field inclinations which makes it a potential flare precursor. Also, the radiative damping time has implications for atmospheric heating. The introduction of wave reflection in the phase dispersion model provides better estimates of the acoustic cutoff frequency and radiative damping times, along with direct measurements of the reflection coefficient in the solar atmosphere.

10:00 AM- *Jupiter's South Temperate Current over the last 134 years*

Richard W. Schmude, Jr., Gordon State College

The planet Jupiter has over a dozen currents that move at different speeds. One of these is the South South Temperate Current (SSTC). It lies at latitudes of between 37 degrees and 42 degrees south. It has been observed since 1888 and is the focus of this talk. The data cover the period 1888 to 2022 and have been analyzed. The main conclusions of this analysis are 1. there can be year-to-year changes in wind speeds exceeding 10 %; 2. there have been statistically significant changes in wind speed during different 20-30 year time periods and 3. The speed of the SSTC has steadily increased over the last 30 years.

10:20AM- *Astronomy at Georgia Tech*

Jim Sowell, Georgia Tech

A description of the various and many astronomical groups and research endeavors at GT.

10:40 AM-11:20 Coffee Break and Posters

11:20 AM- *Close Stellar Encounters*

Alexandra Yep, Ayla Evans, Carey Felius, Nia Suitt, Agnes Scott College

When groups of stars collide, stars may pass very close to each other, potentially kicking up comets from each other's Oort clouds and causing heavy bombardment events. To ascertain how frequently association collisions occur and what effects these may have on stars and their solar systems, we survey six stellar associations in the plane of the Galaxy, looking for association interactions and resulting possible close stellar encounters. We find that an association in this region may experience an association collision every 20 Myr, and stars within that association may on average experience a close stellar encounter every 84 Myr due to association collisions.

11:40 AM- *When Stars Fell on Georgia: Updates on Investigations into Regional Meteorites, Impacts, and Ejecta Deposits*

R. Scott Harris[1], Edward F. Albin[2], Steve J. Jaret[3], (1) Charleston Planetarium

(2) Department of Science, Technology, Engineering, and Math, American Public University, 111 W. Congress Street, Charles Town, WV 25414

(3) Department of Physical Science, Kingsborough Community College (CUNY), 2001 Oriental Boulevard, Brooklyn, NY 11235-2398

Georgia's seventh witnessed meteorite fall and recovery on September 26, 2022, the same day the planetary defense community successfully altered the orbit of the asteroid 65803 Didymos, serves as a reminder that Georgia and the surrounding region has a significant geologic record of Earth's encounters with meteoroids, asteroids, and comets. For the last 25 years, we have led the major investigations into the record of extraterrestrial impacts and ejecta deposits in Georgia and been collaborators on other research into nearby events that likely had effects on our state. We will review the latest characterizations of ejecta deposits from the 66 Ma Chicxulub impact and the 35.5 Ma Chesapeake Bay impact that occur in the Atlantic Coastal Plain. We will update the evidence for a c. 800-million-year-old impact in west-central Georgia, the Manchester-Woodbury structure, as well as its possible connection to the lunar crater Copernicus and an ancient asteroid or cometary shower in the Earth-Moon system. And we will provide the latest information on the recent meteorite fall recovery near Junction City of what preliminary data suggest is an L 4/5 ordinary chondrite.

12:00 PM- *Spectroscopic Line Modeling of the Fastest Rotating O-type Stars*

Katherine Shepard (1), Douglas R. Gies (1), Lex Kaper (2), Alex de Koter (2)

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We present a spectroscopic analysis of the most rapidly rotating stars currently known, VFTS102 (v sin$i$ = 649 +/- 52 km s−1; O9: Vnnne+) and VFTS285 (v sin$i$ = 610 +/- 41 km s−1; O7.5: Vnnn), both members of the 30 Dor complex in the Large Magellanic Cloud. This study is based on high-resolution ultraviolet spectra from Hubble Space Telescope/Cosmic Origins Spectrograph and optical spectra from the Very Large Telescope (VLT) X-shooter plus archival VLT GIRAFFE spectra. We utilize numerical simulations of their photospheres, rotationally distorted shape, and gravity darkening to calculate model spectral line profiles and predicted monochromatic absolute fluxes. We use a guided grid search to investigate parameters that yield best fits for the observed features and fluxes. These fits produce estimates of the physical parameters for these stars (plus a Galactic counterpart, ζ Oph) including the equatorial rotational velocity, inclination, radius, mass, gravity, temperature, and reddening. We find that both stars appear to be radial-velocity constant. VFTS 102 is rotating at critical velocity, has a modest He enrichment, and appears to share the motion of the nearby OB-association LH 99. These properties suggest that the star was

spun up through a close binary merger. VFTS 285 is rotating at 95% of critical velocity, has a strong He enrichment, and is moving away from the R136 cluster at the center of 30 Dor. It is mostly likely a runaway star ejected by a supernova explosion that released the components of the natal binary system.

12:20 PM-1:20 PM Lunch and Posters

1:00 PM Committee Meeting, attend if you plan to host a meeting in the future

1:20 PM- How *Galactic Clouds are Like Bicycles*

Robin Shelton, M. Elliott Williams, University of Georgia

Bicyclists like to ride in a pack because this formation reduces their air resistance and, if they are situated just right, pulls them forward. This is due to the Bernoulli Effect. In order to investigate the magnitude of the effect, we simulated clustered high velocity clouds in the Magellanic Stream and compared with recent survey data. We found that the clouds do, indeed exhibit the Bernoulli Effect.

1:40 PM-*Heliophysics and Machine Learning: Capturing the Current Picture*

Slava Sadykov, Georgia State University

The increased interest of the Heliophysics community in machine learning techniques is reflected in the exponential growth of the number of peer-reviewed publications, conference talks and sessions, and related funding opportunities over the last decade. Although a broadly defined topic of (operational) space weather forecasting remains the primary area where machine learning is applied, there are more and more use cases appearing beyond this area (including pattern recognition in observational and modeling data sets, enhancement of the observational data, speed up of the simulations, preparation of the science-ready data sets, etc.). In this talk, I will provide a high-level overview of how machine learning techniques are helping to aid the field of Heliophysics, attempt to cluster the related research efforts into several broadly defined categories of problems, and map the cross-disciplinary heliophysics research currently performed at Georgia State University into this picture.

2:00 PM- *Are Satellites Planes Around Milky Way Like Galaxies Just Showing Us Accretion Along the Filaments?*

Xinghai Zhao (1), Paola Gonzalez (1), Guobao Tang (2), Grant Mathews (2)

1 Dalton State College, Dalton, GA, 2 University of Notre Dame, Notre Dame, IN

The phenomenon that satellite galaxies in the Milky Way tend to distribute along a flat plane has been observed for decades. Recently, such planes of satellites have also been discovered in Andromeda and Centaurus A. They have shown signs of rotation around the main galaxies. These observations may have serious tension with current ΛCDM cosmology since such satellite systems are very rare in Milky Way-like galaxies in current cosmological simulations using ΛCDM. In this study, we find satellite planes are rather common by analyzing large samples of Milky Way-like galaxies in the latest high-resolution hydrodynamical cosmological simulations through the IllustrisTNG project. We observe that 20% of satellite systems can form planes as thin as the Milky Way. In particular, by studying the accretion process of satellites along filaments of the main galaxies, we find a strong correlation between the thinness of the satellite plane and the distance of the satellites to filaments. We believe accretion along filaments plays a significant role in the formation of thin satellite planes around Milky Way-like galaxies. We find planes of satellites are not likely to have long-lived rotational support in the simulations. More observed dynamical data from satellite systems is needed to confirm the existence and duration of rotational support and, thus, the tension between observation and ΛCDM cosmology.

2:20 PM- *An analysis of Stellar Kinematics in a Sample of Quiescent Galaxies using the Galaxy IFU Spectroscopy Tool (GIST) and IFS data from the Atlas3D Project.*

Lucas Alonso-Munoyerro, Merida Batiste, Emory University

This thesis attempts to analyze infrared Integral Field Spectroscopy (IFS) stellar kinematic data obtained by Capellari et al. (2011), in their ATLAS3D Project in an effort to better constrain the stellar velocity dispersions of a sample of quiescent galaxies, with known supermassive black holes masses. To find this, we will perform an analysis with the help of the Galaxy IFU Spectroscopy Tool (GIST), a pipeline that uses a penalized Pixel-Fitting method (pPXF) to fit the line-of-sight velocity distribution and measure the stellar kinematics. Using this pipeline, I intend to develop a galaxy batch processing guide, implementing it to obtain the stellar kinematics of multiple galaxies at once. A final, and most relevant objective is to combine refined measurements of effective radii for these galaxies, which will be obtained by BRAVE students, with their corresponding kinematic data to plot an m-σ relation. In this talk I will discuss the motivation for this project, as well as describing the publicly available GIST software that will be used in the analysis, as well as talk about what we plan to do with our results and the relevance of such.

2:40 PM- *Simulating the Dynamics of AGN in Relation to the Mass of the Black Hole using AMUSE: A Continuation of the BRAVE Program*

Eric Zhang, Merida Batiste, Emory University

Observations of galaxies are well documented, but it is difficult to distinguish the extent of different structural components within a single galaxy based solely on observations. Therefore, simulations of galaxies that are similar to the observed data will enable us to understand the effects of different types of galaxy structures on the measured properties of galaxies. Specifically, we want to find a way to isolate and separate the bulge dynamics from the disk and any other structures. We use the simulation software Astrophysical Multipurpose Software Environment (AMUSE). AMUSE creates particle sets, allowing us to modify and analyze specific stars within the Plummer model. Our final goal is to compare with observational data from integral field unit (IFU) spectroscopy on our stimulation. We hope to generate synthetic IFU observations of galaxies with separate bulge dynamics.

3:00 PM-3:20 PM Coffee Break and Posters

3:20 PM- *Astro-Tourism in Georgia*

Philip Groce, Helping Planetariums Succeed, LLC

As populations and associated light pollution grow in the Southeastern US, there are fewer and fewer dark sky sites for both professional and amateur astronomers. Perhaps, more significantly, there are even fewer dark sky sites open to the public for casual observing. National and State parks are recognizing that their domains offer not just wildernesses and vistas to be explored during the day but also offer the added value of awe-inspiring nighttime skies. This paper is about the efforts of the Okefenokee Swamp Park to develop an Astro-Tourism program at one of the few dark-sky sites east of the Mississippi.

3:40 PM- Do Exoplanets Exist Around High Velocity Star Systems?

Braven Lyall, Idan Ginsburg, and Sébastien Lépine, Georgia State University

A total of 573 objects have previously been identified as high velocity stars. We are using existing Gaia data to confirm their status as such. We are then conducting a systematic survey of the entire Gaia EDR3 catalog to identify previously unknown high velocity stars. Of particular interest to us is the prospect of detecting planetary companions, which has yet to be discovered. We will attempt to observe these companions via the transit method aided by TESS data.

4:00 PM- Ethno-Astronomy

Matt Marone, Mercer University

One of the most popular cloudy night activities in my introductory astronomy class is ethno-astronomy. The objective of the activity is to research asterisms and sky traditions of non-European cultures. Students choose an asterism that is important to the desired culture and attempt to "connect the dots" by mapping to the official IAU list of star names. With this knowledge, students attempt to reconstruct the asterism in *Starry Night* astronomical software. *Starry Night* is easy to edit and designed for users to enter their own asterisms. Once the software is modified my students can follow the progression of their asterism throughout the year and correlate its position with important cultural activities. Their final product consists of a report, power point and *Starry Night* data file. I will share some examples of student work and comments describing how this assignment impacted them. This activity also connects to my own research on the astronomical traditions of the Mvskoke (Creek) Nation.

4:20 PM- *Closing Remarks*

Matt Marone, Mercer University

Posters

Formaldehyde in the Diffuse Interstellar Cloud MBM 40

Loris Magnani, Mackenzie Rose Joy, University of Georgia

We present observations of the formaldehyde (H2CO) 1(1,0)-1(1,1) transition at 4830 MHz in the diffuse interstellar cloud MBM 40. 97 positions along a cloud ridge were observed resulting in 70 detections. The formaldehyde map is similar to the CO(J=1-0) map but a detailed comparison of the two molecular tracers may show saturation in the formaldehyde. A velocity analysis of the regions detected in H2CO reveals that turbulence is likely responsible for the cloud structure.

New Insights into AGB Nucleosynthesis From Deep, High-Resolution Near-Infrared Spectroscopy of Planetary Nebulae

N. C. Sterling, H. L. Dinerstein, K. F. Kaplan, A. Hanham, University of West Georgia

We present elemental abundances in six Galactic planetary nebulae (PNe) from deep, high-resolution (R = 50, 000) 0.82–1.27 µm spectra obtained with the Habitable-zone Planet Finder (HPF) on the 10-meter Hobby-Eberly Telescope. The primary motivation of these observations is to detect emission lines of heavy elements (atomic number Z > 30) in the poorly explored spectral region at which the HPF is sensitive, including recently identified transitions of Te and Xe ions (Sterling 2020, Galaxies, 8, 50). These elements can be enriched in PNe if their asymptotic giant branch (AGB) progenitors experienced slow neutron(n)-capture reactions (the s-process). We have identified 70 to 200+ emission lines in each target, providing the most complete line lists for ionized nebulae at these wavelengths. In addition to Te and Xe lines, we have also identified Sr in the spectrum of IC 5117, the first detection of this element in an astrophysical nebula. We combine the HPF data with published optical and near-infrared spectra of each object to compute ionic and elemental abundances of each species detected. Significant s-process enrichments are found in each object, exceeing a factor of 10 relative to solar in some objects, while the relatively small enrichment of Sr compared to Kr and Rb suggests that Sr is significantly depleted into dust. These are the first results of a larger survey of ∼25 PNe with the HPF, and provide important constraints to theoretical models of AGB nucleosynthesis, in which uncertainties such as the treatment of mass loss, convection, and rotation can lead to uncertainties exceeding factors of 2–3 in elemental yields. We acknowledge support from NASA-GSGC awards AP646543 and AP1175893, and NSF award AST 1715332.

Investigating the Variability of Extreme Debris Disks from Disk Detective

Mingxuan Liu, Alissa Bans, Emory University

Debris Disks (remnants of planetesimal collisions) can reveal major events in the formation process of solar systems. While finding debris disks was the primary goal of the NASA-launched citizen science project Disk Detective, this project also uncovered other types of objects, primarily Young Stellar Objects (YSO), Classical Be/Shell stars, and a mysterious subclass of debris disks with exceptionally large amount of dust: Extreme Debris Disks. Extreme Debris Disks have similar infrared excess to both Young Stellar Objects and other types of candidates; however, given the different ages and natures of these objects, we may be able to differentiate Extreme Debris Disks from YSOs (and other types of objects) via their variability. To examine the variability of interested objects, we used data from the Transiting Exoplanet Survey Satellite (TESS) and analyzed them with the Lightkurve python package that helped us remove scattered light and obtain accurate light curves. Furthermore, we established an assessment matrix that could classify targets into following categories based on their variability and features on the Lomb-Scargle Periodograms: Periodic Variable, Quasi-Periodic Variable, Irregular Variable, Low-Amplitude Quasi-Periodic Variable, and Not Variable. We found that high-amplitude variability is more frequent among YSOs, who are composed of predominately quasi-periodic or irregular variables; however, Extreme Debris Disks have a low occurrence of variability, and those that are variable are mostly low-amplitude quasi-periodic variables. In addition, we observed that there exists a positive correlation between Hα emission and stellar variability for the YSO candidates, which could give us clues about the accretion activities in these systems. In the future, we will conduct more analyses to compare the variability between different types of Disk Detective candidates, trying to answer questions about the physical mechanism behind their variability and understand how variability might be used to classify Disk Detective candidates when other data are unavailable.

The N/O vs. O/H Relation for the CLASSY Sample

Mabel G. Stephenson, Karla Z. Arrellano-Córdova, Danielle A. Berg, Matilde Mingozzi & Bethan L. James

The relationship between nitrogen-to-oxygen (N/O) ratio and gas-phase metallicity (O/H) in star-forming galaxies provides insight into their chemical evolution processes and star formation histories, and traces enrichment of the interstellar medium (ISM) by intermediate-mass ($3.5 M_\odot \leq M \leq 8 M_\odot$) and massive ($M > 8 M_\odot$) stars. We present an analysis of the N/O vs. O/H relation of 45 nearby dwarf star-forming galaxies in the Cosmic Origins Spectrograph (COS) Legacy Archive Spectroscopic SurveY (CLASSY) treasury sample. CLASSY comprises high-resolution far-ultraviolet spectra from the Hubble Space Telescope as well as ancillary optical spectra taken with several ground-based telescopes. The CLASSY sample encompasses a broad range of physical and nebular properties, allowing us to analyze the full N/O vs. O/H trend. Our preliminary results show an agreement with the trend observed in other local star-forming galaxies; at low metallicities ($12+\log(O/H) < 8.0$) N/O is constant, consistent with a metallicity-independent production of N, in contrast to high metallicities ($12+\log(O/H) > 8.0$) where N/O increases with

O/H as expected for the metallicity-dependent production of N during the CNO cycle, as seen in nearby H II regions. We also compare N/O to other galaxy properties, such as the star formation rate (SFR) and total stellar mass, but find no significant trends. MGS acknowledges support from NSF REU grant AST-1757983 (PI: Jogee) funded by the NSF and Department of Defense.

Revealing the Heavy Element Compositions of Planetary Nebulae with the NASA-IRTF

S. F. Gordon[1], N. C. Sterling[1], H. L. Dinerstein[2], & W. D. Vacca[3]

1: University of West Georgia, 2: University of Texas at Austin, 3: SOFIA-USRA, NASA Ames Research Center

We present chemical compositions of 11 planetary nebulae (PNe) observed in the J and L bands at high resolution (R = 20, 000) with the iSHELL spectrometer on the NASA Infrared Telescope Facility (IRTF). These data have revealed the first detections of [Br IV] emission lines at 3.3437 and 3.8092 µm in three PNe, and [Rb III] 1.3566 µm in two objects. Due to its high elevation, the IRTF is the only ground-based facility that is able to peer past the edge of the J band to observe this line of [Rb III], its only collisionally-excited transition. Br and Rb can be produced by s-process nucleosynthesis during the asymptotic giant branch (AGB) evolutionary stage that immediately precedes PN ejection, and combined with observations at other wavelengths, our results provide the most accurate abundances of these species in any PN to date. We also report the abundance of Zn in several objects via the [Zn IV] 3.6247 µm transition, and of the refractory element Ca derived from the [Ca IV] 3.2065 line. Zinc is the only iron-group element that is not highly refractory, and is a useful metallicity tracer in PNe. Several H2 transitions have also been identified in the L band spectra of four of the targets, and we detect CH+ transitions in NGC 7027 that were previously reported by Neufeld et al. (2020, ApJ, 894, 37). Ca, Zn, Br, and Rb ionic abundances were converted to elemental abundances through the use of ionization correction factors (ICFs) that rely on the ionic fractions of light elements such as O, S, Cl, and Ar. To improve the accuracy of the ICFs we recomputed light element abundances from published optical spectra, and incorporate detections of additional Br and Rb ions detected at other wavelengths. We find that Br is enriched by factors of 3-4 relative to solar in the objects in which it was detected, while the Rb abundance is enhanced by factors of 30-40. Using Zn as a proxy for Fe, we find slightly subsolar metallicities in four objects. Interestingly the Zn abundances tend to be slightly lower relative to solar than O and other α-capture elements, although the small sample size and abundance uncertainties prevent a firm conclusion. We gratefully acknowledge support from NASA-GSGC grants AP646543 and AP1175893, and NSF award AST 1715332.

Photometric Surface Temperature Measurements of FT Orionis

John Keiley, Gregory Feiden, University of North Georgia

FT Orionis (FT Ori; V = 9.26) is a detached, double-lined A-type eclipsing binary star system with a 3.15 day orbital period. Stellar properties have been determined for this system previously, but

there is disagreement about the effective temperature of the secondary star with estimates varying by up to 500 K. This complicates tests of stellar evolution models, which require precise and accurate stellar properties. We present initial results of an effort to redetermine the fundamental properties of FT Ori using data from the North Georgia Astronomical Observatory. We collected Bessell B-, V-, and R-band photometric time-series data between November 8, 2021 and April 25, 2022. Effective temperatures were determined by measuring the flux ratio between the primary and secondary flux minima, and the out-of-eclipse flux for each photometric passband. The best fit effective temperatures for the two stars were determined to be Teff,A = 9600 ± 280 K, Teff,B = 8800 ± 240 K assuming the stellar spectral energy distributions can be modeled as a Planck function. Continued photometric observations of the system and future spectroscopic observations will allow for more refined effective temperatures and a complete determination of the stellar properties including stellar masses, radii, and interior density distribution accessible through apsidal motion measurements.

A Comparison between Two Ways of Ionizations in the Universe

Chen Wang[1], Eric Goetz[2], Robin Shelton

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Collisional ionization and photoionization are the two primary processes for ionizing atoms in the Universe. Currently there are many studies about their effects on cloud material. However, typically only one or the other mechanism is used in the study. In order to determine which mechanism is responsible for more ionized gas, we compared their effects on clouds, specifically on High Velocity Clouds (HVCs). We simulated HVCs in two ways. We first used CLOUDY to simulate a cloud in collisional ionization equilibrium (CIE) experiencing photoionization due to an external radiation field, as is typical of photoionization analyses. We then used FLASH to simulate a cloud with non-equilibrium collisional ionization (NEI) undergoing dynamic mixing with the ambient medium. We found that the dynamic NEI model results in significantly more ionization than photoionization does. This comparison shows that collisional ionization dominates photoionization.

Systematic Distribution Sampling of IceCube Neutrinos for use in a Multi-Messenger Search for Gravitational Waves and Compact Binary Coalescences

Shamita Hanumasagar, Hannah Griggs, Viviana Cáceres Barbosa, Laura Cadonati, Georgia Institute of Technology

In addition to gravitational waves, compact binary coalescence (CBC) events produce neutrino fluxes. In accordance with IceCube and LIGO data, neutrino sky locations and energies upon arrival at Earth follow common distribution laws. We created a Monte Carlo sampler to emulate IceCube data and produce a randomised representation of neutrinos in a selected area to eventually apply to a large-scale gravitational-wave and neutrino pipeline. To do so, we seek to create a mutable and automated sampler to predict neutrino energies along a declination range at a user-specified bin value, which may be used to detect CBC events and verify the validity of our collection and testing methods. We completed the automated code in Python using IceCube's past ten years of data and information from LIGO's second observing run, utilising a declination choice from -5 to 90 and a bin size of 10, which resulted in varying distribution evaluations. Further modifications will include implementation of machine-learning to mitigate compilation and run times in addition to including information about right ascension and GPS times to simulate events with augmented information.

Educational Models for Youth Astronomers

Aleksandr Selbach, University of North Georgia

The North Georgia Astronomical Observatory at the University of North Georgia focuses on a combination of research and public outreach to help advance science and encourage young minds to pursue a career in STEM. Currently, our public outreach program provides children and their parents with a tour of the facility and a stunning view through our telescope.

However, while the public observing nights are well received, they lack hands-on activities and visual aids to help cement the topics we cover. To address this issue, we have put together five interactive lessons to help add educational value to our public nights. The program follows a general theme, with lessons starting on the small scale with our solar system, and expanding in scale to our local group. Each lesson is targeted at a specific age group ranging from K-12th grade and includes age-appropriate lesson material and hands-on activities. These learning tools can now be employed during our open nights to help students better understand what we are observing while on the tour. Furthermore, this educational material can be utilized when school groups, homeschool groups, and scouting groups come to the observatory.

Each lesson is accompanied by physical models to help students visualize the concepts we are discussing. These models include scale models of our solar system, the local solar neighborhood, the Orion spur, globular clusters, and the Local Group. All models are handmade, to scale, and used as visual aids throughout the lessons.

Here, we present the activities and lessons we developed.

Identifying UFOs in the COS FUV spectra of PDS 456

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We conduct a study of quasar PDS 456 using COS FUV spectra from the Hubble Space Telescope (HST), where we identify the potential presence of a UV UFOs intrinsic to the quasar. We identify all possible absorption troughs in 7 spectra due to the host galaxy's ISM and find 2 lines that are potentially high velocity troughs due to Ly-α (v~0.09c). Furthermore, these lines are clearly detected in the earliest spectrum but are not detectable in subsequent observations. This suggests that the presence of these troughs are intrinsic UFOs to the host galaxy based on the variability.

An Investigation into the Relationship between the Global Covering Fraction and Luminosity of an AGN

Alton V. Patrick, Jay P. Dunn, and Steven B. Kraemer, Georgia State University

We conduct a study of quasars observed by the Sloan Digital Sky Survey (SDSS) to explore the relationship between the global covering fraction and the luminosity of an AGN. The SDSS archives contain found 18,000+ quasars with spectra between a redshift of 2.00 and 2.30, which provides spectral coverage of N V, Si IV, C IV and Mg II. We find that 3000+ of the objects showed absorption troughs with FWHM velocities of ~500 km s-1 due to outflows intrinsic to the quasars. In each case, the absorption trough is evident and agrees in velocity space between all detectable ions. We compare detection fractions for each ion as a function of the lLl of the AGN and find a clear cutoff lLl of approximately 1046 ergs s-1, where objects less than this cutoff show a significantly lower detection rate of outflows.