2021 SPACE ASTRONOMY SUMMER PROGRAM SYMPOSIUM
THURSDAY, AUGUST 5 • 2021
SPACE TELESCOPE SCIENCE INSTITUTE
BALTIMORE • MARYLAND

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STScI  SPACE TELESCOPE SCIENCE INSTITUTE
The Space Astronomy Summer Program (SASP) continued its virtual-only program for students and mentors alike in 2021. While working in a remote environment continues to be challenging, the interns met these challenges and succeeded.

During this 29th year of STScI's summer intern program, we continue to work towards these goals:

- To expose undergraduates to leading research in astrophysics, and the workings of a space-based observatory
- To provide participants with opportunities for growth, achievement, and personal development
- To place students in a cohort of friends and colleagues

In this Program Booklet, you'll find seventeen interns who were part of SASP, and four additional students who interned for STScI outside of SASP. We are happy to be able to share the accomplishments of all of these interns with you!

— Carolyn Slivinski

2021 SASP Program Chair, on behalf of the SASP Executive Committee
SESSION 1: https://bluejeans.com/192110046/2422

10:00–10:10 AM EDT Carolyn Slivinski  INTRODUCTION
10:10–10:20 AM  Alejandra Huertas [Mentor: Yotam Cohen]
NEW AND IMPROVED SATURATED-PIXEL FLAGGING FOR THE ACS/HRC CCD DETECTOR
10:20–10:30 AM  Michael Kunz [Mentor: Susan Mullally]
USING TESS TO MONITOR THE JWST SPECTROPHOTOMETRIC STANDARDS
10:30–10:40 AM  Michelle Ramsahoye [Mentor: Lou Strolger]
CREATING AN INTERFACE FOR PACMAN: A TOOL FOR PROPOSAL ASSIGNMENTS THROUGH MACHINE-LEARNING TECHNIQUES
10:40–10:50 AM  Aiden Kovacs [Mentor: Catherine Martlin]
TRACKING SATELLITE TRAILS IN WFC3 IMAGES OVER TIME
10:50–11:00 AM Gray Farley [Mentor: Amy Jones]
CREATING AND COMPARING NEW CALIBRATION FILES FOR HST/STIS UV DETECTORS
11:00–11:10 AM BREAK
11:10–11:20 AM Razan Hamed [Mentor: Andreea Petric]
SPATIALLY RESOLVED SPECTROSCOPIC OBSERVATIONS OF A NEARBY, INFRARED LUMINOUS GALAXY: NGC 7592
11:20–11:30 AM Alexander Culkin [Mentor: Tyler Desjardins; co-mentor: Andrea Bellini]
THROUGH THE EYE OF THE BEHOLDER: SIMULATING ROMAN SPACE TELESCOPE OBSERVATIONS
11:30–11:40 AM Zach Cowell [Mentor: Bryan Holler]
DEVELOPING EXTENDED JWST PSFS FOR SOLAR SYSTEM OBSERVATIONS NEAR GIANT PLANETS
11:40–11:50 AM Dr. Nancy Levenson [Deputy Director]  COMMENTS
11:50–NOON Sneha Sunilkumar [Mentor: Elaine Mae Frazer]
INVESTIGATING THE ACCURACY OF THE COS EXPOSURE TIME CALCULATOR
12:00–1:00 PM BREAK/LUNCH

SESSION 2: https://bluejeans.com/838450675/1023

1:00–1:10 PM Jose Ruiz Casias [Mentor: Harry Ferguson]
NEAR-FIELD COSMOLOGY WITH SEMI-RESOLVED DWARF GALAXIES
1:10–1:20 PM Michael Asfaw [Mentor: Rachel Plesha]
UNIT TESTING WITH THE COSMIC ORIGINS SPECTROGRAPH (COS) CALIBRATION PIPELINE
1:20–1:30 PM Andrew Tran [Mentor: Nimisha Kumari]
USING MUSE TO STUDY THE EFFECT OF DIG ON PHYSICAL PROPERTIES OF NEARBY STAR-FORMING GALAXIES
1:30–1:40 PM Khalid Mohamed [Mentor: Scott Fleming]
SEARCHING FOR SINGLE-TRANSIT EVENTS IN TESS LIGHTCURVES WITH MACHINE-LEARNING
1:40–1:50 PM Kathleen Hamilton-Campos [Mentor: Raymond Simons; co-mentor: Greg Snyder]
LIGHTING THE EVOLUTIONARY PATH: USING HST/CANDELS IMAGING TO TRACK THE FORMATION HISTORY OF STELLAR DISKS
1:50–2:00 PM Nami Nishimura [Mentor: Cassi Lochhaas]
USING FOGGIE TO INVESTIGATE THE METALLICITY OF THE CGM
2:00–2:10 PM BREAK
2:10–2:20 PM Dareen Awwad [Mentor: Nicole Arulanantham; co-mentor: Joel Green]
IDENTIFYING PLANET-FORMING DIPPER DISK CANDIDATES IN TESS LIGHT CURVES WITH MACHINE LEARNING
2:20–2:30 PM Owen Crise [Mentor: Matilde Mingozzi]
SPATIAL DISTRIBUTION OF METALLICITY IN AGN HOSTS FROM THE MANGA SURVEY
2:30–2:40 PM Aassik Pazhani [Mentor: Andrew Fox]
CONSTRAINING THE SIZE OF GALACTIC HALO CLOUDS
2:40–2:50 PM Wendy Mendoza [Mentor: Brendan Gannon; co-mentor: Greg Snyder]
SIMULATED GALAXY SHAPE MEASUREMENTS FOR THE ROMAN SPACE TELESCOPE AND MIGRATION OF LEGACY ASTRONOMICAL TOOLS FOR EXTENDED MAINTAINABILITY
2:50–3:00 PM Victor Soto Castro [Mentor: Klaus Pontoppidan; co-mentor: Joel Green]
DEFINING REQUIREMENTS FOR FUTURE FAR-INFRARED TELESCOPES OBSERVING PROTOPLANETARY DISKS AND PROTOPRISTARS
3:00–3:10 PM Carolyn Slivinski  CLOSING REMARKS
Identifying Planet-forming Dipper Disk Candidates in TESS Light Curves with Machine Learning

Dareen Awwad  Bridgewater College
Mentor – Nicole Arulanantham, Giacconi Fellow
Co-Mentor – Joel Green, Instrument Scientist

Planet formation takes place in disks of gas and dust surrounding young stellar objects (YSOs). Studying these protoplanetary disk systems establishes critical initial conditions that carry through to the final compositions and distributions of exoplanets. A particularly interesting opportunity to probe the innermost regions of protoplanetary disks comes from “dipper disks,” which are systems that display consistent variability in optical brightness. The behavior is attributed to dusty material in the disks, at radii where rocky, Earth-like planets are expected to form. This dust occults the YSOs and reduces the amount of light reaching the observer, producing “dips” in the measured system brightness over time (light curve). By characterizing the structure and composition of the occulting material, we can acquire otherwise inaccessible information about these environments while planets are still forming in the disks. In order to identify the most promising dipper-disk candidates for further analysis, we used machine learning to classify light curves from YSOs that were observed with the Transiting Exoplanet Survey Satellite (TESS). The dataset was assembled by cross-matching the Disk Detective and TESS catalogs, resulting in a total of ~3500 light curves from systems with disks. For each light curve, we measured “features” that were previously found to be characteristic of dipper-disk behavior (see e.g., Hedges et al. 2018). A random forest classifier was then used to categorize the light curves based on these features. We will pursue follow-up observations of our new dipper-disk candidates in the future, in order to further characterize the dusty occulting material. Our work will provide unique insight into the disk structures that arise close to the YSOs during the process of planet formation.
Where data reduction is an essential part of astronomy, unit testing is fundamental in software engineering where parts of software are tested with small, self-contained scripts. The Cosmic Origins Spectrograph (COS) calibration pipeline, CalCOS, previously did not have any of these unit tests formally written. In this effort, new unit tests for modules inside of CalCOS were written and run using GitHub actions to continuously check that any updates to the code would not break the pipeline. During the process, modules in CalCOS that were outdated, incomplete, or could be improved were flagged for future updates. This presentation will outline the progress thus far and the upcoming efforts that will continue.
In this work, we present the steps involved in developing point-spread functions (PSFs) large enough to evaluate the contributions of scattered light at the positions of many giant planet satellites. These PSFs will be powerful tools for planning future solar system observations with all science instruments on the James Webb Space Telescope (JWST). The major steps involved include convolution of the PSF with a model of the giant planet and the addition of scattered light not accounted for by WebbPSF. The final products will be monochromatic PSFs at each integer wavelength between 1 and 28 microns (as well as 0.7 microns).
The interstellar medium (ISM), made up of gas and interstellar dust, is the “primary repository” of galaxies, where both star formation (SF) and Active Galactic Nuclei (AGN) activity can take place. Emission lines from galaxy spectra represent one of the most powerful tracers of ISM properties, allowing us to understand the impact of SF and AGN activities on a galaxy, and ultimately on galaxy evolution. In this context, integral field spectroscopy (IFS) has allowed us to make a considerable step forward, since it offers the possibility of peering inside galaxies, collecting spectra over a two-dimensional field of view, and thus allowing the mapping of their ISM properties. In this project, we have selected one galaxy, characterized by AGN activity in its center, from the Mapping Nearby Galaxies at Apache Point Observatory (MaNGA) survey. In this talk, we will show its ISM properties in terms of dust extinction, density, dominant source of ionization and metallicity content, and the comparison of its metallicity distribution to the one found for star-forming galaxies in the literature. This is a first step to better understand the role played by AGN activity in shaping metallicity radial distributions in MaNGA galaxies.
We describe our work simulating science data from the Roman Space Telescope Wide Field Instrument. These data will be used as part of the verification and scientific validation of the Roman science data pipeline. We adapt pre-existing Fortran code for simulating images by adding a Python wrapper, converting FITS format output files to the ASDF Roman data format, and implementing catalog-generation tools for simulating astronomical scenes. In this presentation, we describe in detail the process used for simulating Roman data, the ASDF format used for Roman, and the scientific considerations used in generating the input catalogs.
Having updated and current calibration files is crucial for properly reducing and processing astronomy data. The Hubble Space Telescope (HST)/Space Telescope Imaging Spectrograph (STIS) team is working on updating the pixel flat fields for the Ultraviolet detectors to improve the quality of the STIS data. To create these new files, I first upgraded the scripts by writing replacement IDL code to remove IRAF code dependencies and tested the code replacement. I then ran the new script to generate new p-flats and compared them with the previous ones. For the final tests, I re-reduced HST data with the new p-flats to determine whether there was enough improvement to deliver the new p-flat reference file, and wrote up my findings in a technical report.
In the local Universe, Luminous InfraRed Galaxies (LIRGs) are one of the most useful objects to understand how galaxies evolve. Local LIRGs are more numerous than other objects at comparable bolometric luminosity, so they constitute a privileged population to study. LIRGs are rich in molecular gas, which is the fuel for star formation. In this project we analyzed wide-field, spatially resolved spectroscopy of the Hα recombination line to study the morphology and kinematics of the ionized gas in an interacting LIRG system, NGC 7592. We compare these data with MIR spectral maps from Spitzer’s Infrared Spectrograph to identify and compare the interstellar medium (ISM) phases in this system. We estimate gas consumption and inflow rates and what they may tell us about NGC 7592’s future and galaxy evolution.
In disk galaxies such as our Milky Way, older stars generally inhabit a thicker disk than younger stars. Two competing (and conflicting) models have attempted to explain this result: one in which stars form in thin disks that subsequently thicken through dynamical interactions, and one in which stars form in progressively thinner disks as galaxies age. A direct measure of the evolution of the thickness of stellar disks to high redshift is needed to discriminate these scenarios. Using archival UV-IR HST imaging from the CANDELS survey, we investigate the evolution of the stellar scale height of galaxies from $z = 2$ to today. In this talk, I will show preliminary radial scale height profiles of galaxies at $z = 1$, highlight relevant population trends as a function of mass and galactocentric radius, and discuss future prospects of this work.
During an imaging exposure, CCD detector pixels integrate photoelectric charge linearly over time, until they reach a certain capacity known as the saturation level. Beyond this brightness level, most of the additional charge incident on a saturated pixel tends to spill over into neighboring pixels, resulting in bright, vertical streaks in the output image, and rendering the affected pixels unreliable for most science measurements. For this reason, saturated pixels in ACS images must be accurately identified, and flagged accordingly, so that users of the data can mask or exclude them in their science calculations.

In this work, we study and measure the saturation level of the ACS/HRC CCD detector. We leverage a wealth of archival HRC external imaging data to amass a sample of more than 300,000 stars observed in the F555W filter. We perform aperture photometry on the stars, and then statistically analyze their brightness profiles in order to pinpoint the brightness level at which saturation occurs. The saturation level varies over the detector area, so we bin the data spatially in order to map out the variations. We find an average saturation level of 154k electrons over the whole detector, with a peak-to-peak variation of about ±15k electrons (±10%) around the chip. We demonstrate the efficacy of our method by inspecting the resulting flagged saturated pixels in science images. Our measurements prove to be a significant improvement over the previously measured saturation level, which was analyzed in the early days of the instrument when there was much less data available. We plan to incorporate our new and improved measurements into the CALACS pipeline.
Satellite trails, an anomaly appearing as bright lines stretching across an image, are troublesome as they obscure portions of that image and can cause issues with scientific accuracy. In this project, we present an automated tool which continuously tracks the number of satellite trails detected by the Wide Field Camera 3 (WFC3) UVIS and IR detectors. As various private companies, such as Amazon’s Kuiper satellites and SpaceX’s Starlink, begin to periodically launch batches of satellites, plotting these trails over time should help indicate whether Hubble, or specifically the WFC3 instruments, are affected by these launches. Further, we also present results of a new script, based off the ACS detsat function, which automatically detects satellite trails as an alternative to the previous manual method of Quicklook team members identifying trails by eye. Not only does this provide in-depth testing of the detsat function, but we also can compare the manual and scripted results of satellite trails over time, providing more certainty in any trends seen.
Calibration of the science instruments of the James Webb Space Telescope (JWST) is performed using “standard candle” stars. Their spectral types include white dwarfs, A, and G stars because they can be modeled to high accuracy. Selecting stars which give off the same amount of light within 2% allows accurate modeling of stellar objects. Therefore, stars which vary in brightness because of pulsation, rotation, eclipses, flares, or any other reason may need to be removed from the list of candidates. The Transiting Exoplanet Survey Satellite (TESS) has observed 35 of the candidate calibration stars. We examined the TESS light curves for evidence of periodic and transient phenomena, and report on any detected variability. Using Lomb-Scargle periodograms, we looked for any significant periodic signals of less than 10 days. We detected several variable stars in the set, and the peak-to-peak amplitudes in one were larger than 1%.
Simulated Galaxy Shape Measurements for the Roman Space Telescope and Migration of Legacy Astronomical Tools for Extended Maintainability

Wendy Mendoza  
University of Texas Rio Grande Valley

Mentor – Brendan Gannon, Senior DevOps Engineer
Co-Mentor – Greg Snyder, Astronomical Data Scientist

Team Bromine works on the conversion of Astroconda to Condaforge, making sure all of its dependencies work along with it. Additionally, we worked on moving some Astroconda installation components to Wheel files. Tasking included installing, testing, and updating Astroconda using technologies such as Git, Jenkins, and Groovy. In addition, Wendy gained exposure to Linux-based operating systems, and containerization of software components utilizing Docker. Wendy then assessed the performance of a Docker-based Roman Science Platform prototype using Jupyter Notebooks designed to benchmark the computing resources required for scientific image analysis. Expanding on this benchmark analysis using synthetic images, Wendy determined how measurements of galaxy shapes and the computing resources needed to obtain them, depend on depth.
Searching for Single-Transit Events in TESS Lightcurves with Machine Learning

Khalid Mohamed  
Amherst College

Mentor – Scott Fleming, Branch Manager  
Archive Science Application Branch

The Transiting Exoplanet Survey Satellite (TESS) is NASA’s latest exoplanet hunting space telescope. TESS has a notably wide field of view—24 × 96 degrees of the sky is observed at 21-arcsecond resolution with each observation. Unlike its predecessors, TESS downloads a full image of its field of view on a frequent basis. This means that during the first two years of the mission, hundreds of thousands of stars can get high-quality photometric light curves over a month or more at a cadence of 30 minutes, provided aperture photometry is measured on all the point sources. A team at MIT has provided calibrated and extracted light curves for millions of stars from these images as a contributed data product to the archive. Our project uses these light curves, combined with simulated models of transits, to search for long-duration, isolated transit events that only occur once in a light curve, and thus are not found during the exoplanet search conducted by the mission. These signals could be caused by long-period transiting exoplanets which are scientifically valuable, but hard to find without a large number of targets and measurements. We experiment using a Random Forest classifier that is fed a variety of metrics that can be calculated from the light curves directly. We optimize the classifier using known, shorter-period transiting planets already identified from the data by the MIT team, and a transit-simulator package called BATMAN, and then apply what we learn to search for these similar, but longer-period, signals.
Using FOGGIE to Investigate the Metallicity of the CGM

Nami Nishimura SUNY (State University of New York) Geneseo
Mentor – Cassi Lochhaas, STScI SMO Postdoc

The circumgalactic medium (CGM) is the region of space surrounding galaxies, outside of the stars and interstellar medium; understanding its dynamics is important to galaxy formation and evolution. Metals, which are any element other than hydrogen and helium, are crucial parameters in models of galaxy evolution because they are only formed in processes where stars are abundant, mostly near the center of galaxies. Therefore, tracking the path of metals and the change in metallicity, the ratio of metal abundance to hydrogen abundance, inside the CGM gives us a better understanding of the movement of the gas, such as accretion onto central galaxies, outflow out of galaxies, or recycling back to the galaxy again.

I developed a python code to investigate these flows using a cosmological simulation of Milky Way-like galaxies, “Figuring Out Gas & Galaxies in Enzo” (FOGGIE). We found that metallicity varies more in hot gas than in cold gas, so we investigated mass and metal flow through the CGM. We found that there is more mass flowing into the galaxy than out of it, but more metals flowing out of the galaxy than in. Inflows are predominantly at low temperature, while outflows are predominantly at high temperature. Within the CGM, the flows are constant over radius, which means that metal outflows from the galaxy pass through the CGM and do not remain there. This suggests that the high variation in metallicity of the hot gas is related to time-dependent outflows that may translate into observed scatter of metallicity in the CGM.
The Milky Way is surrounded by a gaseous halo that acts like a Galactic atmosphere. The halo contains inflowing and outflowing clouds that can be analyzed in absorption using ultraviolet (UV) spectra of background sources. In this SASP research project, we have constrained the size of these clouds using pairs of Hubble Space Telescope/Cosmic Origins Spectrograph (HST/COS) spectra from the CLUES program, a large international collaboration targeting star clusters in external galaxies. We have used Voigt component-fitting software to analyze four pairs of CLUES targets with small (~arc-minute) separations, located in different regions of the sky. By comparing the strength of various UV absorption lines between the two sightlines in each pair, we have constrained the spatial scale of the Milky Way halo clouds, thus revealing new information about the properties of the Galactic halo.
The paradigm in peer-reviewed resource allocation has shifted, placing stronger emphasis on creating the most equitable reviews possible. There is a growing need for tools like PACMan to manage the selection of the most qualified reviewers, and reduce known and unknown biases in assignments. This project has focused on building an HTML-based interface to PACMan, providing administrators with easy-to-use-tools to determine (a) the best candidates for topical review panels, (b) the best matches of reviewers to proposals, and (c) the best assignments of proposals to reviewers after considering potential conflicts of interest.
The space density (number per unit volume) of dark-matter halos predicted by the standard cold-dark-matter power spectrum vastly exceeds the space density of galaxies. Possible explanations include (1) that the power spectrum turns over at low mass, (2) that dwarf-galaxy formation is extremely inefficient, or (3) that we are missing galaxies in our census of the universe. This project is aimed at improving the dwarf-galaxy census. We are developing a CNN-based technique to identify and estimate the distances to isolated dwarf galaxies that are close enough to have a very-slightly mottled appearance due to stochastic fluctuations in the number of stars per pixel. This talk will summarize the evolution of the network architecture as we have tried to improve performance and as we gradually make the image simulations more and more realistic.
Several parallel efforts are underway to design the next generation of far-infrared observatories. Obviously, these designs are driven by the need to address scientific challenges. Among several key science cases for far-infrared observatories is the need to obtain sensitive far-infrared spectroscopy of planet-forming disks around young stars. Since young stars are often located within the bright nebulosity of their parent clouds, this component can often be a limiting factor in telescope performance, even if cooled down to limit thermal self-emission. This project develops a sample of protoplanetary disks and protostars to investigate what size far-infrared telescope is needed to not be limited by cloud nebulosity.
The exposure time calculator (ETC) for the Cosmic Origins Spectrograph (COS) on Hubble predicts the count rates and signal-to-noise ratios for observations taken with the COS instrument. It also alerts observers when excessively bright objects may do damage to the detectors, making it a critical tool for maintaining the health and safety of the instrument.

In the ETC, observers can select many different COS observing modes, template spectra, and observing conditions, allowing them to estimate the exposure times needed to get the best data for their science goals.

In this project, we investigate how accurately the COS ETC predicts count rates and signal-to-noise ratios. Using past COS observations, we compare the ETC results supplied by observers in their proposal files to the count rates and signal-to-noise ratios computed from the actual COS data. We create a database of these comparisons along with other relevant parameters for all past observations in order to identify any systematic under- or over-estimations. We present early results evaluating the ETC accuracy across time and for different types of targets and observing modes. The results are a valuable resource for the COS team and may be used to update the COS ETC to provide more accurate results for future observers.
Using MUSE to Study the Effect of DIG on Physical Properties of Nearby Star-forming Galaxies

Andrew Tran University of Georgia
Mentor – Nimisha Kumari, ESA/AURA Astronomer

In this work, we use integral field spectroscopic data of 24 nearby star-forming galaxies ($\sim 10^{8.5-11} \, M_\odot$) taken with the state-of-the-art instrument MUSE on the Very Large Telescope. The MUSE data allows us to probe a wavelength range of 4650–9300 Å allowing us to probe several emission lines of interest and the properties encoded therein. The high spatial resolution of the MUSE data set allows us to separate the HII region from the diffuse ionized gas (DIG) on the basis of classical emission-line diagnostic diagrams. We study the effect of DIG on the metallicity gradients within our galaxy sample by using O3N2 metallicity diagnostic for HII and DIG–dominated region. Moreover, we also make use of the publicly available hcm-teff code to estimate the ionization parameter and effective temperature in order to study their radial gradients and the potential effect of DIG on radiation hardness. Such spatially resolved studies are essential to understanding the intricate processes involved in galaxy formation and evolution.
Great strides have been made in the study of exoplanet atmospheres in the last decade. However, this field is still highly resource-limited, carving out individual results by pushing the limits of current instrumentation. In this landscape, the delivery of the NEID extreme-precision spectrograph unveils a new capability for the direct detection of reflected light in the optical from the ground via high-resolution spectroscopy. We aim to leverage the exquisite stability and broad wavelength coverage of NEID, in combination with a tailored observing strategy, to retrieve the reflected light signature from the historic exoplanet 51 Pegasi b. This planet has a favorable planet-star flux ratio, and a complementary detection of water in the near-infrared, that would make the optical detection particularly scientifically insightful. In addition to marking a technological milestone and serving as a proof of concept for analytical techniques, such a detection would pave the way for the study of atmospheric albedos with imaging and spectroscopy on future ground- and space-based exoplanet missions. Chromatic, or even broadband albedo measurements, will provide critical observational constrains on competing multidimensional models, and greatly refine our understanding of exoplanet atmospheres.
**I AM**
- an avid film/TV enthusiast
- minoring in math because my school makes me
- a music minor who repairs guitars

**I WAS**
- a circus performer for 7 years; my specialty was Aerial silk and gymnastics
- born on Valentine’s Day

**I LOVE**
- anything and everything about the outdoors
- to take sunset pictures
- to make, test/tweak, and play with paper airplanes
About the SASP interns

I HAVE

• been to 4 out of 7 continents
• eaten an exotic food: curry iguana (and it tasted pretty good)
• four German shepherds, all of whom I love dearly (and equally)!!
• made mods for Stellaris and Kerbal Space program
• a cat (Princess Leia), a husky (David Bowie) & a white dog (Kylo)

I CAN

• say my ABC’s backwards, but I have never needed to use this skill
• celebrate Star Festival on 7/7 in Japan, by writing wishes and decorating bamboo