2023 SPACE ASTRONOMY SUMMER PROGRAM SYMPOSIUM

Thursday, August 3, 2023

Space Telescope Science Institute

Baltimore • Maryland

RHO OPHIUCHI (NIRCAM IMAGE)

STScI | SPACE TELESCOPE SCIENCE INSTITUTE

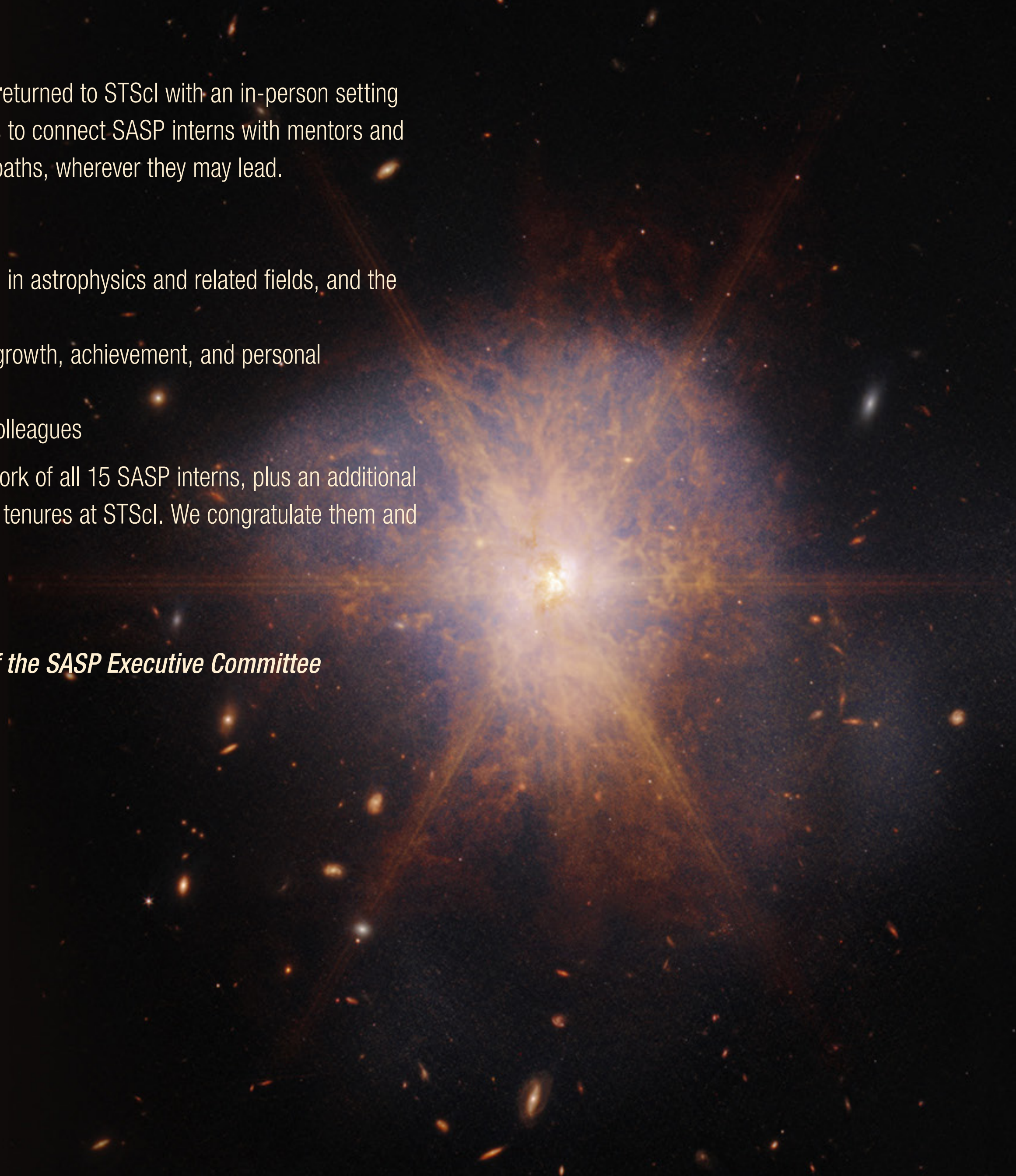
The Space Astronomy Summer Program (SASP) returned to STScI with an in-person setting in 2023, for the 31st year of SASP. Our program works to connect SASP interns with mentors and others who can help guide them in their future career paths, wherever they may lead.

SASP works towards these goals:

- To expose undergraduates to leading research in astrophysics and related fields, 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

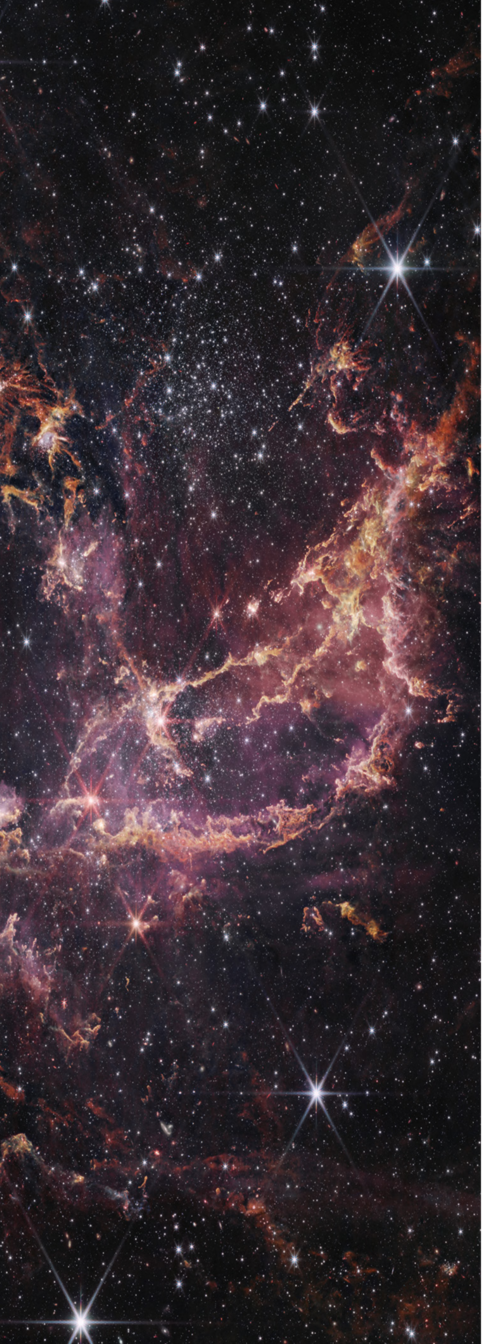
In this Symposium Program Booklet, you will see the work of all 15 SASP interns, plus an additional non-SASP intern, and the work done during their short tenures at STScI. We congratulate them and want to share their accomplishments with you!

— **Carolyn Slivinski**
2023 SASP Program Chair, on behalf of the SASP Executive Committee



ARP 220 (NIRCAM AND MIRI IMAGE)

10:00–10:10 AM EDT	**Carolyn Slivinski, Welcome Remarks**
10:10–10:20 AM	**Marc Postman, Director's Office Remarks**
10:20–10:30 AM	**Grace Sweetak [Mentor: Sebastian Gomez]** Finding the Missing Tidal Disruption Events
10:30–10:40 AM	**Maggie Ju** **[Mentor: Bryan Hilbert, co-mentors Mario Gennaro, Ben Sunnquist]** Mitigating the effects of persistence in NIRCam observations
10:40– 10:50 PM	**Nicolas McMahon [Mentor: Bhavin Joshi, co-mentor Lou Strolger]** Improving SN Ia host galaxy mass step characterization with state-of-the-art SED fitting
10:50–11:00 AM	**Emily Wright [Mentor: Amy Jones]** STIS NUV-MAMA P-flats
11:00–11:10 AM	**BREAK**
11:10–11:20 AM	**James Ball [Mentor: Kelly Lepo, co-mentor Margaret Carruthers]** Alt text for Hubble images
11:20–11:30 AM	**Kali Ferguson** **[Mentor: Malynda Chizek Frouard, co-mentor Jeff Chamblee]** Vuetification of Moving Targets
11:30– 11:40 PM	**Leah Morgen** **[Mentor: Nimisha Kumari, co-mentors Claus Leitherer, Mike Irwin]** Investigating flux calibration of the GMOS-IFU data
11:40–11:50 PM	**Eliot Smith [Mentor: Mark Giuliano, co-mentor Diego Mundo]** UNLOST (Universal Linked Observation Schedulability Tool)
11:50– 1:00 PM	**LUNCH**
1:00–1:10 PM	**R. Anastasia Ericson** **[Mentor: Jason Tumlinson, Co-mentor Laurent Pueyo]** Assessing Technological Readiness and Key Architecture Trades for the Habitable Worlds Observatory
1:10–1:20 PM	**Eugene Lee [Mentor: Ayan Acharyya, co-mentors Anna Wright, Ramona Augustin, Molly Peeples, Jason Tumlinson]** Quantifying Galactic Disk Radius and Metallic Dynamics in Hydrodynamically Simulated Galaxy
1:20–1:30 PM	**Sarai Rankin [Mentor: Nikolay Nikolov, co-mentor Martha Boyer]** Comparative analysis of 1/f noise mitigation strategies for NIRCam data
1:30–1:40 PM	**Turaba Rahman** **[Mentor: Intae Jung, co-mentors Harry Ferguson, Abdurro'uf]** Structural Evolution of Star Formation Activity Inside Galaxies in the Early Universe
1:40–2:00 PM	**BREAK**
2:00–2:10 PM	**Larom Segev [Mentor: Thomas Dutkiewicz]** Spearheading an Open-Source Curriculum for Cloud Science
2:10–2:20 PM	**Joyce Lin [Mentor: Mario Gennaro]** A near-infrared study of the metal-rich globular cluster NGC 6553
2:20–2:30 PM	**Derod Deal [Mentor: Néstor Espinoza]** Building a Treasure Detector: towards a quick-look pipeline for JWST NIRISS FGS guide star data
2:30–2:40 PM	**Kyla Mullaney** **[Mentor: Valentina Abril-Melgarejo, Co-Mentor Logan Jones]** 3D characterization of the ionized gas properties of galaxies in dense structures after the cosmic noon
2:40–2:50 PM	**Carolyn Slivinski, Closing Remarks**



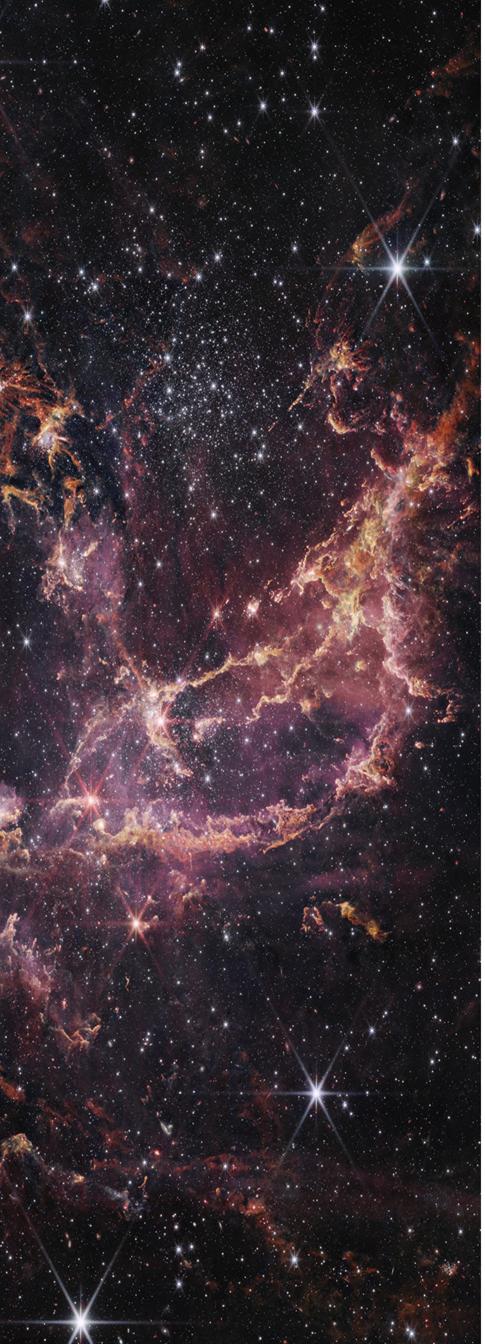
SASP

Finding the Missing Tidal Disruption Events

Grace Sweetak *Rollins College*

Mentor – *Sebastian Gomez (STScI Postdoctoral Fellow)*

A Tidal Disruption Event (TDE) happens when a star comes too close to a supermassive black hole, which tears apart the star, producing a bright flare. Today, we have only found a few dozen TDEs, and they all show a wide diversity of features we do not fully understand. Telescopes around the world are scanning the sky every few nights, looking for new transient sources of light. One of these surveys, the Zwicky Transient Facility (ZTF), finds thousands of transients every month. Among those thousands of new sources, some are good candidates to be TDEs. We have uncovered a sample of roughly 300 TDE candidates selected using the FLEET machine learning algorithm that have not been uncovered before. It is expected 35-50% of these candidates to be TDE's, helping us to significantly increase the current sample size of TDEs.



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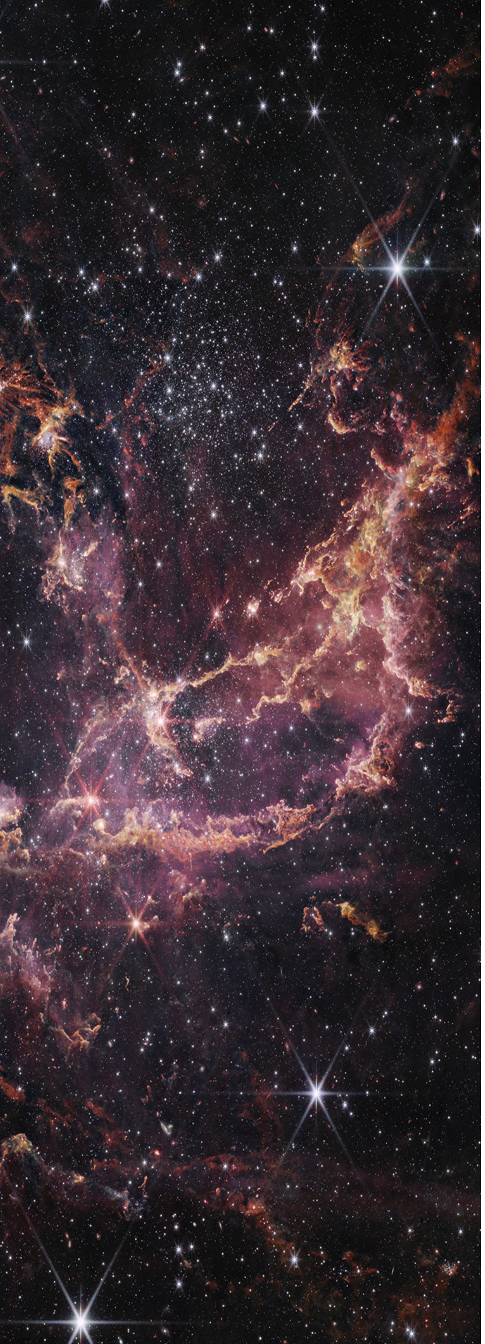
Mitigating the effects of persistence in NIRCam observations

Maggie Ju *University of Rochester*
Mentor – *Bryan Hilbert (Principal Staff Scientist)*
Co-Mentors – *Mario Gennaro (STScI scientist), Ben Sunnquist (Senior Staff Scientist)*

Persistence is a phenomenon related to the trapping of charge in the HgCdTe semiconductor material that makes up near infrared detectors, including those in NIRCam. The higher the total charge accumulated on a pixel, the higher the chance of trapping charge within defects in the detector lattice. This charge is later released on timescales ranging from seconds to hours. This released charge appears as “extra”, unexpected signal in subsequent exposures, and is commonly referred to as latent images or persistence. Once charge is trapped, nothing can be done other than to wait for it to decay. However, persistence can be mitigated by preventing high signal levels and saturation in the first place. While in some cases this is unavoidable, careful observation planning can go a long way in preventing the worst consequences. In this project, we will develop a planning tool that will predict saturation in planned NIRCam observations. These predictions will provide scheduling constraints to avoid excessive saturation and subsequent persistence in NIRCam observations. The tool will use automatic queries of archival images and catalogs to predict fluxes in future NIRCam observations. Archival magnitudes of bright sources will be used to predict the number of “bad actors” in each planned NIRCam image. Archival images (e.g. from 2MASS, Spitzer) will be scaled and projected on to the NIRCam detectors’ layout to predict the corresponding amount of saturation. Diagnostic plots will be produced and organized into a suitable format to guide NIRCam instrument scientists in their review of NIRCam proposals.



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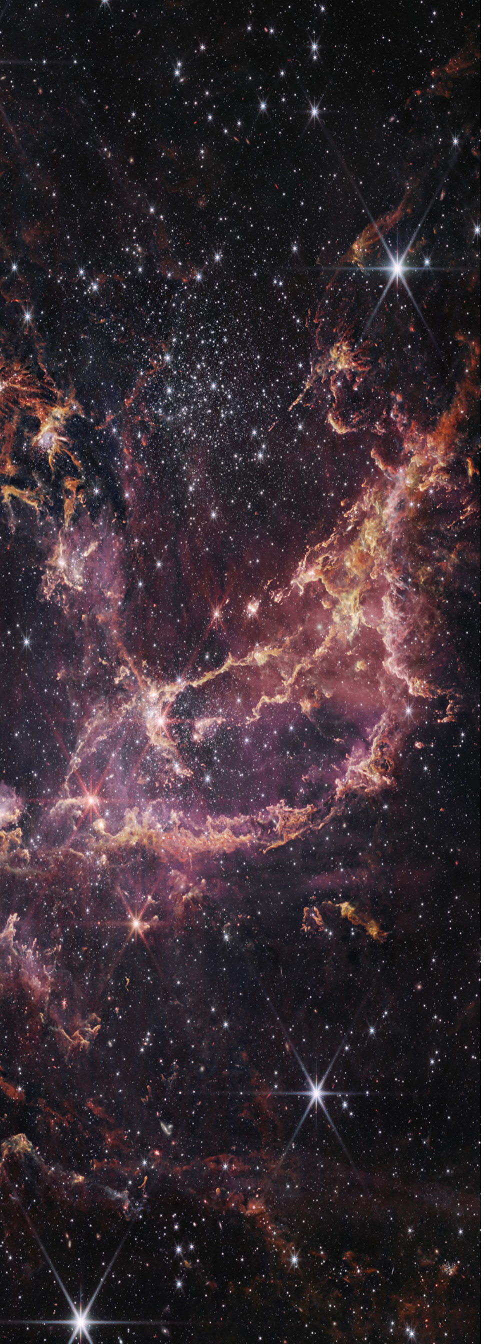
Improving SN Ia host galaxy mass step characterization with state-of-the-art SED fitting

Nicolas McMahon *Boston University*
Mentor – *Bhavin Joshi (Postdoctoral Fellow)*
Co-Mentor – *Lou Strolger (Observatory Scientist)*

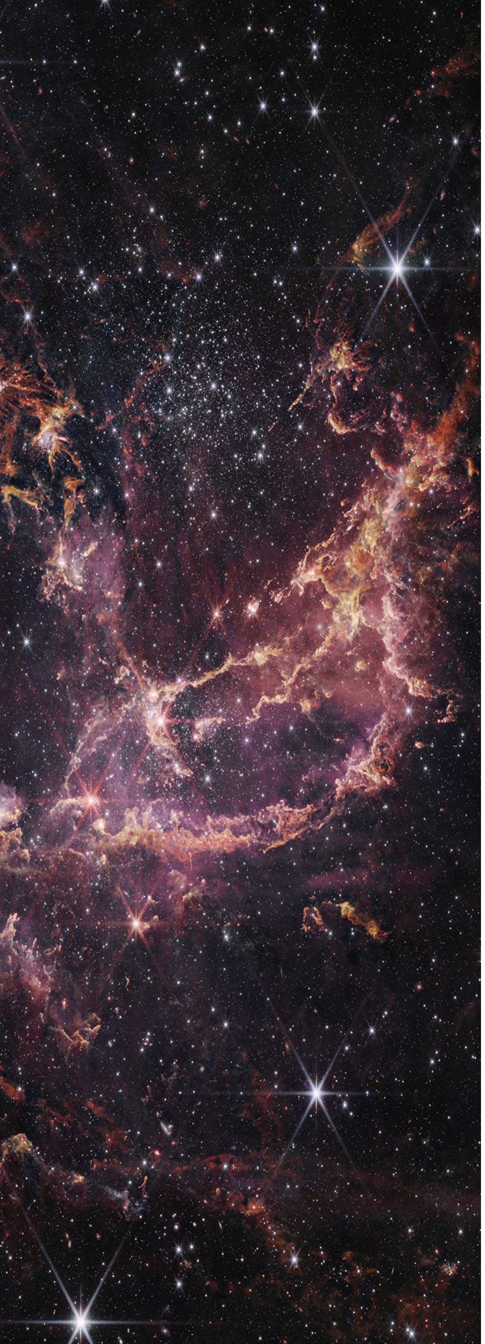
The goal of this project is to improve our understanding of the correlation between type Ia supernovae Hubble residuals and the stellar masses of their host galaxies. This is an empirically observed effect with no obvious physical basis. This project will reanalyze existing multi-wavelength data on host galaxies of type Ia supernovae to derive accurate stellar masses and star formation histories for the Pantheon+ sample. The student's role will be to (i) test out different state of the art SED fitting codes to determine if any of our results are affected by the SED fitting techniques employed, and (ii) to verify host galaxy identification for multiple surveys. This project will allow the student to learn several different skills -- working with astronomical datasets, programming with python, and gaining familiarity with SED fitting and different SED fitting packages/approaches.



STIS NUV-MAMA P-flats

Emily Wright *University of Maryland- College Park*
Mentor – *Amy Jones (Sr. Staff Sci, Sci Sup)*

The pixel-to-pixel variation in sensitivity of the STIS NUV-MAMA detector is known to be slowly evolving with time. The last time new P-flat fields were delivered to the pipeline was 20 years ago. Recently, the STIS team upgraded the code for creating P-flats to remove all IRAF dependencies and generated P-flats for HST Cycles 17-27. I will introduce the STIS NUV MAMA detector and P-flats. Then I will present some comparisons between the final P-flat and intermediate files from the previous version of the code with IRAF dependencies and the new updated version, highlighting the differences seen and how we plan to address them.



SASP

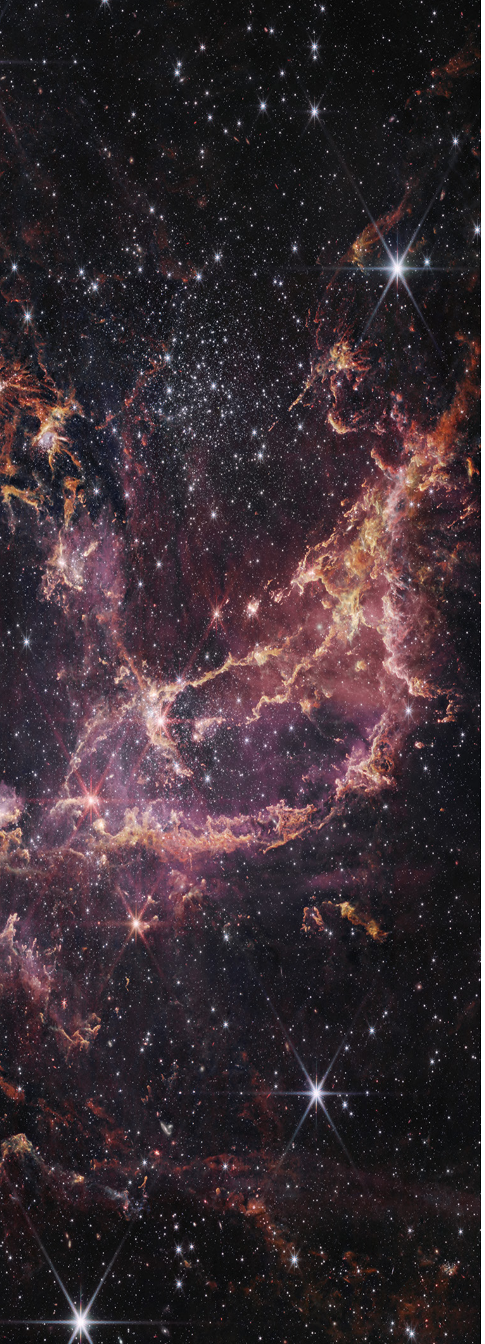
Alt text for Hubble images

James Ball *Arizona State University*

Mentor – *Kelly Lepo (Education and Outreach Scientist, OPO)*

Co-Mentor – *Margaret Carruthers (Deputy Branch Manager, Science Writer)*

Hubble and now Webb images released by NASA and STScI have become iconic, visual representations of the cosmos. However, images and spectra are inaccessible to many blind and visually impaired people. Over the last few years, we have worked to improve the accessibility of our website and resources, which were prominently shared with the release of Webb's First Images and Spectra on July 12, 2022. Short for "alternative text," alt text is a description of an image that is embedded in the HTML code of a website, and can be added by users of many applications including social media platforms. Screen readers, most often used by people who are blind or visually impaired, will read alt text in place of showing an image. The first images and spectra from Webb released by the Office of Public Outreach (OPO) at STScI and all of our news releases since then from Hubble, Webb, and Roman have included our new in-house style of alt text. However, there is a large back catalog of more than 30 years of Hubble images which do not have good image descriptions. In this project, the intern will work with an OPO outreach scientist and science writer to write alt text descriptions for important Hubble images, including Hubble Anniversary Images and Hubble Favorites. This will help to advance STScI's strategic goal of making the world's astronomical information accessible to all.



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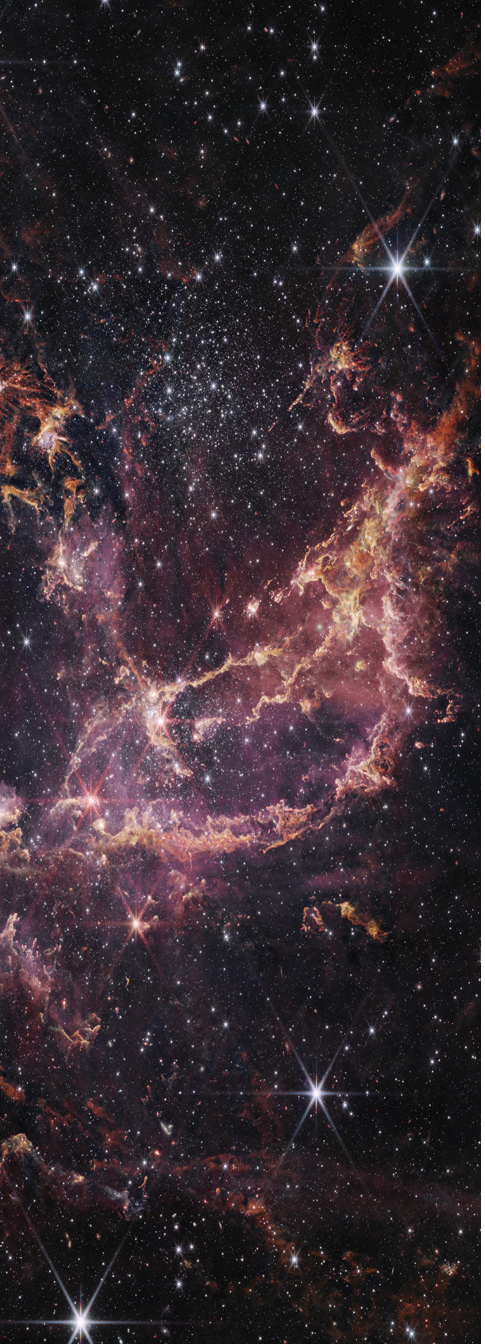
Vuetification of Moving Targets

Kali Ferguson *Towson University*
Mentor – *Malynda Chizek Frouard*
(Senior Software Engineer in MAST)
Co-Mentor – *Jeff Chamblee*
(Senior Software Engineer in MAST)

The intern for this project will connect web applications and APIs to space telescope data in MAST using Python and VueJS. The intern will work on a data visualization project correlating available data with positions of solar system bodies. The result of this project is intended to be used as a part of the new MAST search interface. This is an opportunity to learn modern software development practices (project planning, agile/scrum practices, version control systems, software configuration management, adhering to standard coding practices, using CI/CD) in a combination astronomical science + software development environment.



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Investigating flux calibration of the GMOS-IFU data

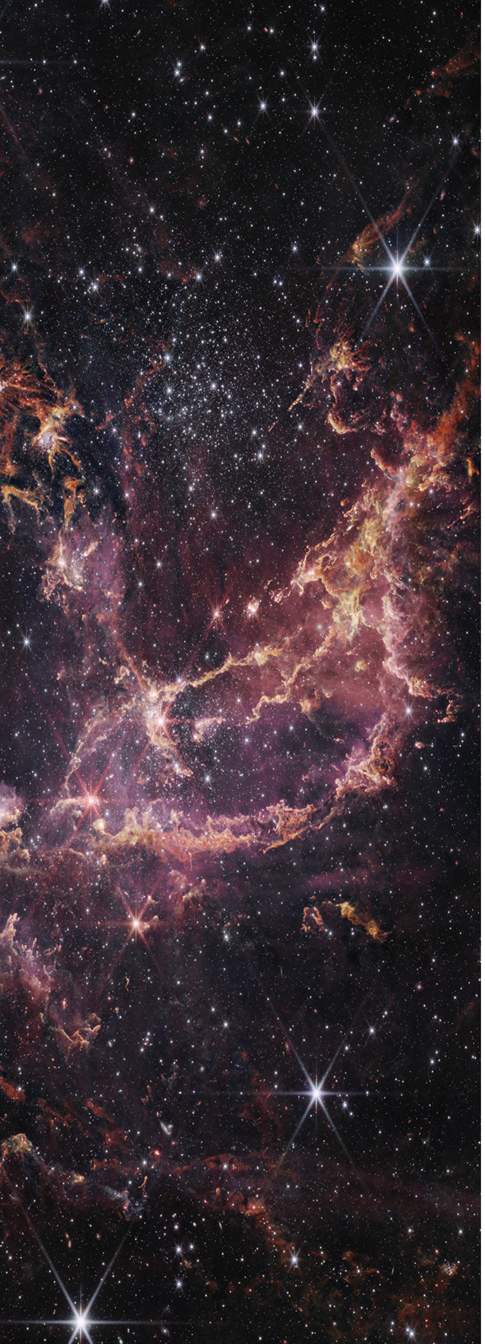
Leah Morgen *University of Florida*

Mentor – *Nimisha Kumari (ESA/AURA Astronomer, STScI)*

Co-Mentors – *Claus Leitherer (Astronomer, STScI)*

Mike Irwin (Emeritus Staff, University of Cambridge)

Integral field spectroscopy is a powerful technique combining the imaging and spectroscopy, and hence is extremely useful in performing the spatially-resolved analysis of extended objects in astronomy. The technique is being employed in several world class telescopes, both in space (e.g., JWST) and on ground (e.g., MUSE/VLT and GMOS/Gemini). However, previous studies have shown signatures of large off-sets in absolute flux calibrations in the data taken with integral field unit (IFU) on the Gemini Telescopes. Hence, in this project we investigate several photometric standard stars which are used for flux calibrations for GMOS-IFU data. In particular, we perform an extensive search of the Gemini Archive for the photometric standard stars for which the good quality stellar spectra are already available from other telescopes, e.g., STIS/HST spectra from CALSPEC. We then reduce the IFU observations of standard stars via the Gemini data reduction pipeline, which includes steps such as flat fielding, wavelength calibration, sky-subtraction, flux calibration and cube-building. We then extract the standard star spectrum from the cube to compare with the model spectrum to check for any systematic effects in flux calibration. Such studies are important to inform community about the careful analysis needed for reducing the GMOS IFU data.



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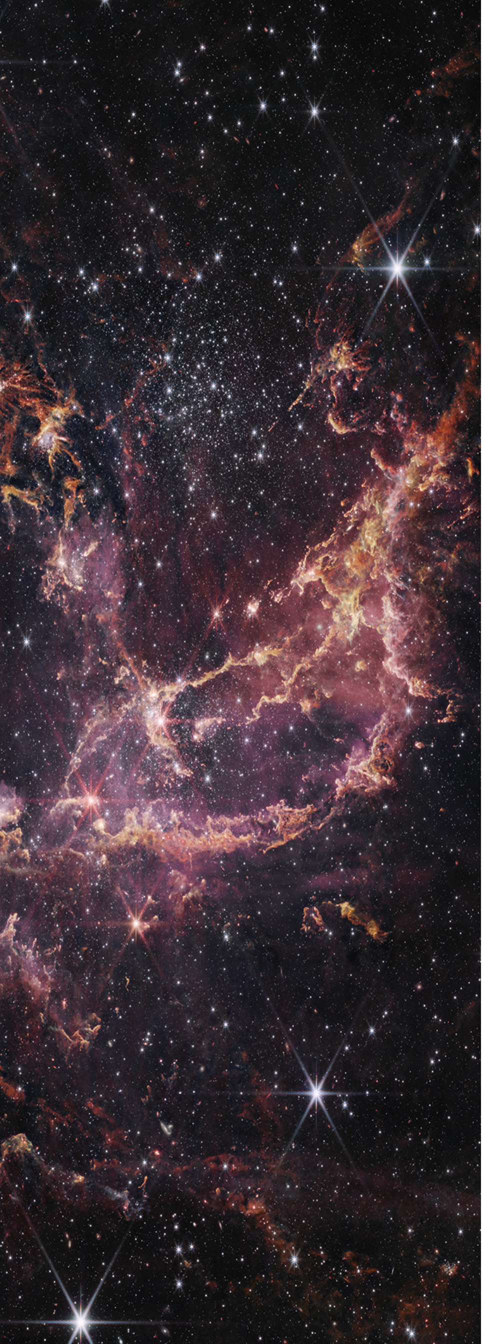
UNLOST (Universal Linked Observation Schedulability Tool)

Eliot Smith *University of Rochester*
Mentor – *Mark Giuliano (Computer Scientist)*
Co-Mentor – *Diego Mundo (Software Engineer)*

The UNLOST tool helps observers determine times when a set of related astronomical observations can be legally scheduled. Observations of a target on a space-based telescope can only be performed at times which satisfy the physical limitations of the telescope. For example, JWST can only observe targets not to close or too far from the sun. Physical constraints also limit how a spacecraft can roll around its boresight. To ensure that instruments are shielded from the sun JWST must observe in a range of at most 11 degrees for a particular target on a particular day. In addition to physical constraints, observations often require additional restrictions in order to achieve the desired astronomical science (e.g. observe an exoplanet). Timing requirements are used to capture periodic phenomenon for a single observation or between pairs of observations. Observing a target at multiple aperture rolls helps resolve the actual target structure within the images. With multiple constraints between observations determining why an observation is or is not schedulable at a given time becomes complex. The UNLOST system advances the state of the art for analyzing observation scheduling constraints. It provides a set of tools that enable a visual and interactive exploration of time and roll constraints between observations, as demonstrated on science programs abstracted from operational JWST programs.



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Assessing Technological Readiness and Key Architecture Trades for the Habitable Worlds Observatory

R. Anastasia Ericson *Capitol Technology University*

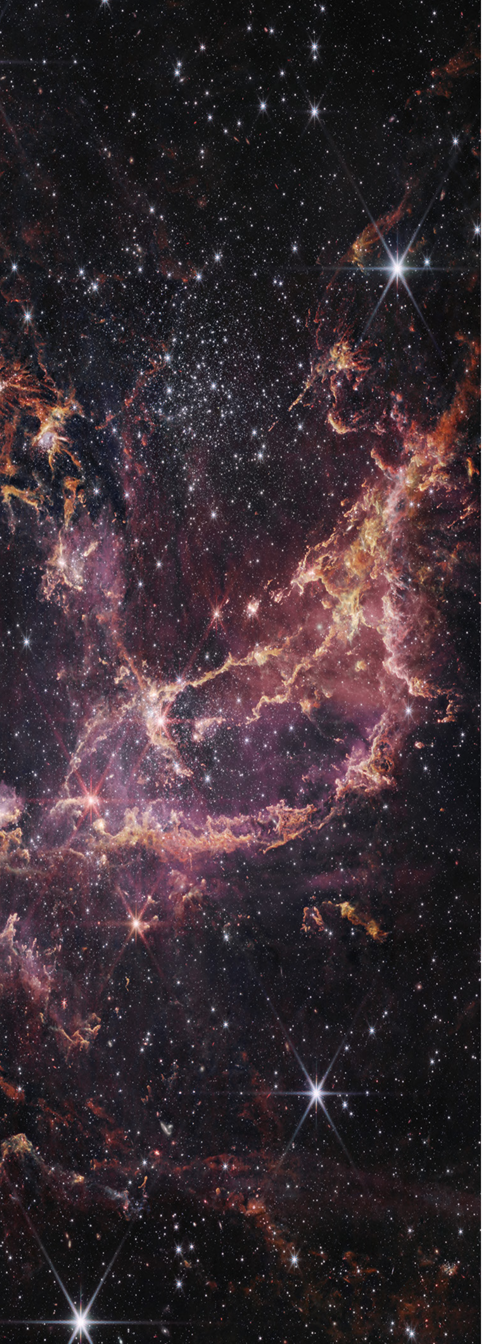
Mentor – *Jason Tumlinson,*

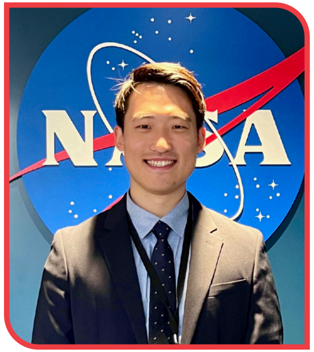
(Astronomer and Head of Community Missions)

Co-Mentor – *Laurent Pueyo*

(CMO Project Scientist for Advanced Technologies)

This year is an exciting time for the future of space astronomy, as NASA has just announced its intent to proceed with the Habitable Worlds Observatory and the New Great Observatories that follow it. Following this announcement, STScI is beginning several strategic initiatives to organize community involvement in the next steps for HabWorlds. This includes a major conference this summer (July), the development of user software tools, and other community engagement threads. This is an opportunity for an interested student with strong communication skills and broad high-level thinking to join this new Observatory in its earliest stages. The intern's exact duties would be determined by interests, skillsets, and mutual agreement.





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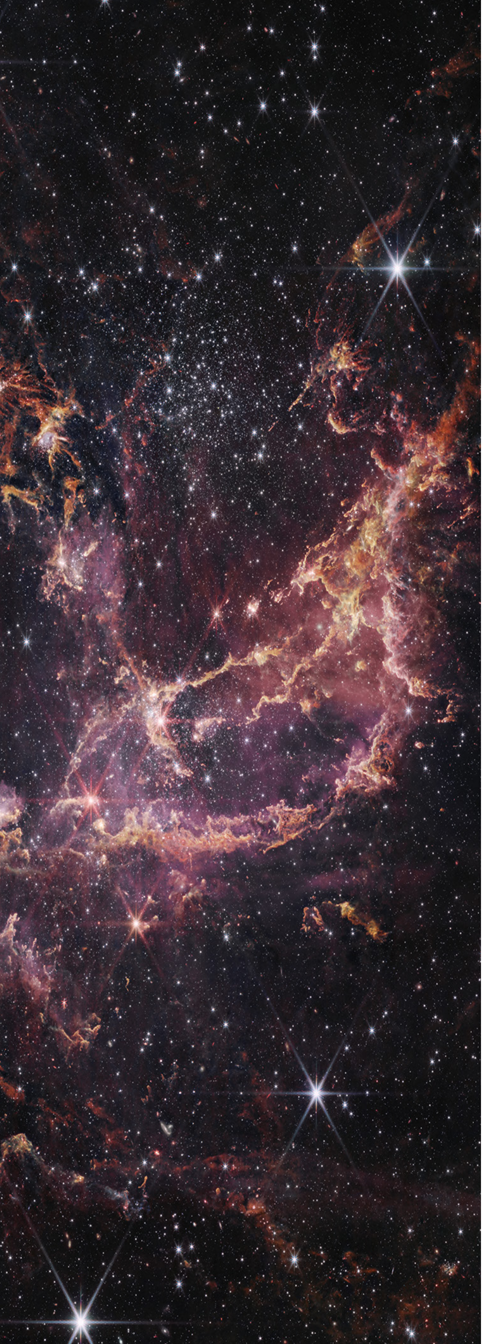
Quantifying Galactic Disk Radius and Metallic Dynamics in Hydrodynamically Simulated Galaxy

Eugene Lee *The University of Texas at Austin*
Mentor – *Ayan Acharyya (JHU post-doc researcher)*
Co-Mentors – *Anna Wright (JHU Postdoctoral Researcher), Ramona Augustin (STScI Postdoctoral Researcher), Molly Peeples, Jason Tumlinson*

The gas in galaxies assembles and evolves over billions of years, governed by various factors. The repeated life cycle of stars produces life supporting elements such as Carbon, Oxygen, Nitrogen, etc., categorised as 'metals'. The distribution of metals in a galaxy can tell us a lot about the galaxy's history -- including, how were stars formed in the galaxy, if it had collided with another galaxy in the past and if there had been any violent ejections. We use the state-of-the-art simulations of galaxies, called Figuring Out Gas & Galaxies in Enzo (FOGGIE), to study how the metals are distributed throughout the galaxy and how this distribution changes with cosmic time. In particular we look at the projection effects of metallicity profile. In order to determine the physical extent up to which we should be constraining the metallicity profile, we model the density profile of the disk too. By fitting a piecewise continuous line to the density profile we determine the size of the galaxy disk and explore the evolution of this size.



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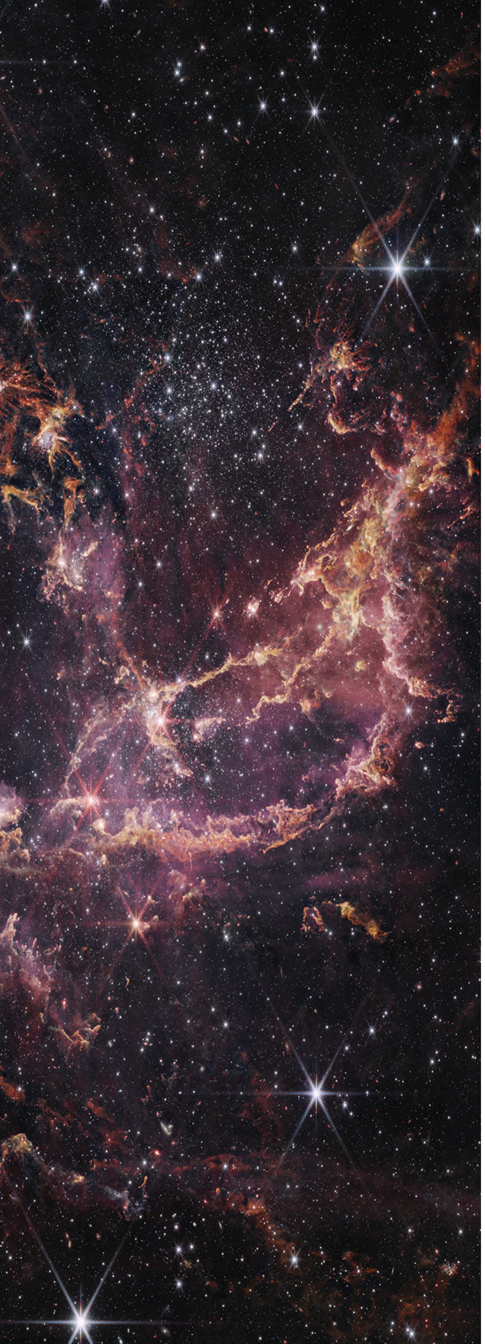
Comparative analysis of 1/f noise mitigation strategies for NIRCam data

Sarai Rankin *Morgan State University*
Mentor – *Nikolay Nikolov (AURA Associate Scientist)*
Co-Mentor – *Martha Boyer (Associate Astronomer)*

Correlated 1/f noise presents as horizontal and vertical striping patterns that vary from row to row and column to column in the imaging and spectroscopic data of all JWST instruments. If not handled properly, it can cause one to overlook targets, or over-estimate the statistical significance of a detection on imaging data and introduce systematic errors in time series observations. Several algorithms have been developed to identify and remove 1/f noise of JWST data, but a comparative analysis of their performance has not been done to identify the most effective methods. In this project, the student will run existing publicly available Python routines on real JWST imaging and time series data and compare the noise-suppressing properties of the separate techniques using quality metrics. The results from this work will inform the astronomy community for the best 1/f noise mitigation strategies.



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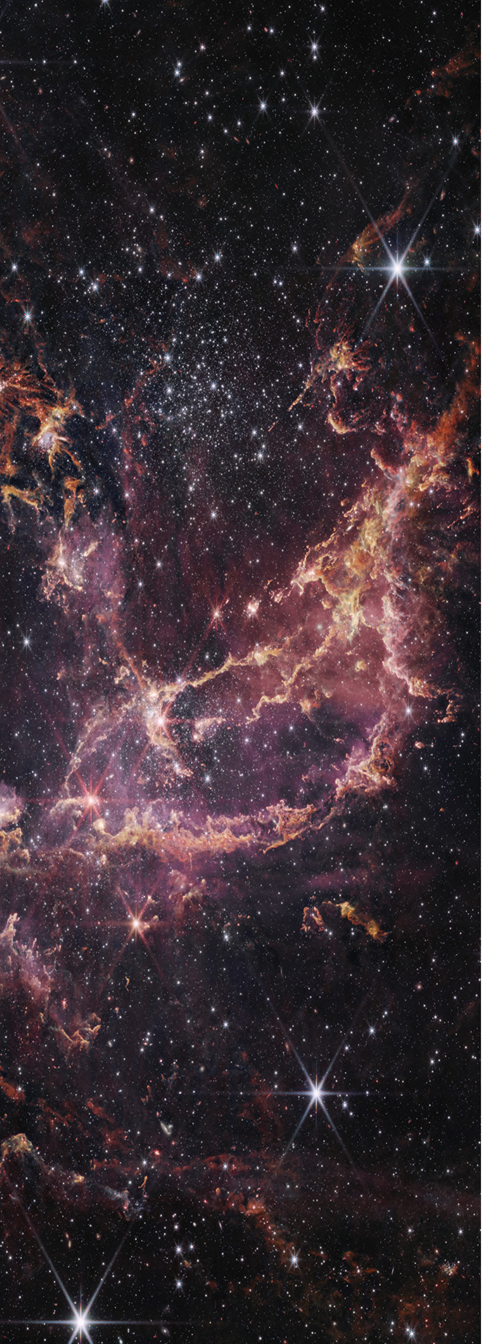
Structural Evolution of Star Formation Activity inside Galaxies in the Early Universe

Turaba Rahman *Kent State University*
Mentor – *Intae Jung (Postdoctoral Researcher at STScI)*
Co-Mentors – *Harry Ferguson (Astronomer at STScI)*
Abdurro'uf (Postdoctoral Fellow at JHU)

We perform a spatially-resolved stellar population study of galaxies in the early universe. We investigate detailed star-formation histories inside galaxies, unveiling spatially-resolved star-formation activities of high-redshift galaxies. The primary task is to perform a state-of-art spatially-resolved spectral energy distribution fitting of galaxies in the early universe with publicly-available deep and high spatial-resolution imaging data of JWST and HST observations. We analyze spectroscopically confirmed high-redshift galaxies with their Lyman-alpha emission detected, characterizing spatially-resolved properties of Lyman-alpha-emitting galaxies in the early universe. Furthermore, the project potentially tackles key questions about when/where galaxies form stars actively and what physical mechanisms regulate star formation.



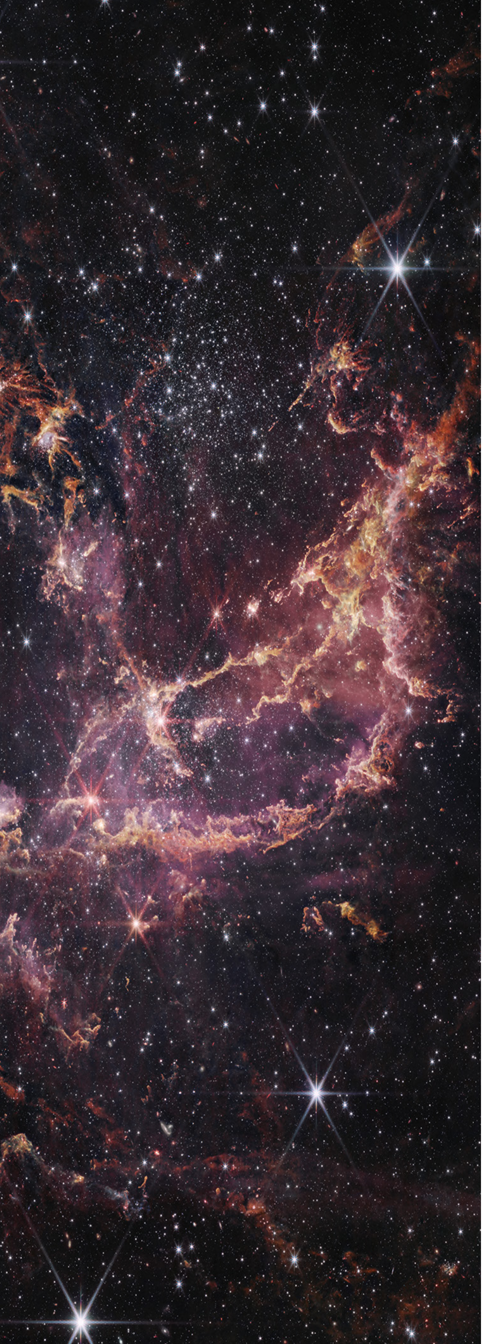
SASP

Spearheading an Open-Source Curriculum for Cloud Science

Larom Segev *Harvard University*

Mentor – *Thomas Dutkiewicz (Archive Analyst)*

The MAST Archive is the home for data from JWST, HST, TESS, Kepler, and over twenty other telescopes. As MAST continues to grow, it becomes increasingly important that we educate the astronomy community on the diverse datasets and tools we offer. Specifically, this project is aimed at increasing engagement with the TIKE platform: a cloud-based JupyterHub system that enables rapid access to the many terabytes of TESS observations. To that end, this project will develop a curriculum that demonstrates realistic scientific use cases for the platform. The culmination of this work will be running a "MAST class"; we'll use this opportunity to run demonstrations of the lessons and get feedback from the community. Concrete work items include writing new Jupyter Notebooks, helping to present material during webinars, and curating a "textbook" repository that will allow anyone to run their own version of our class.



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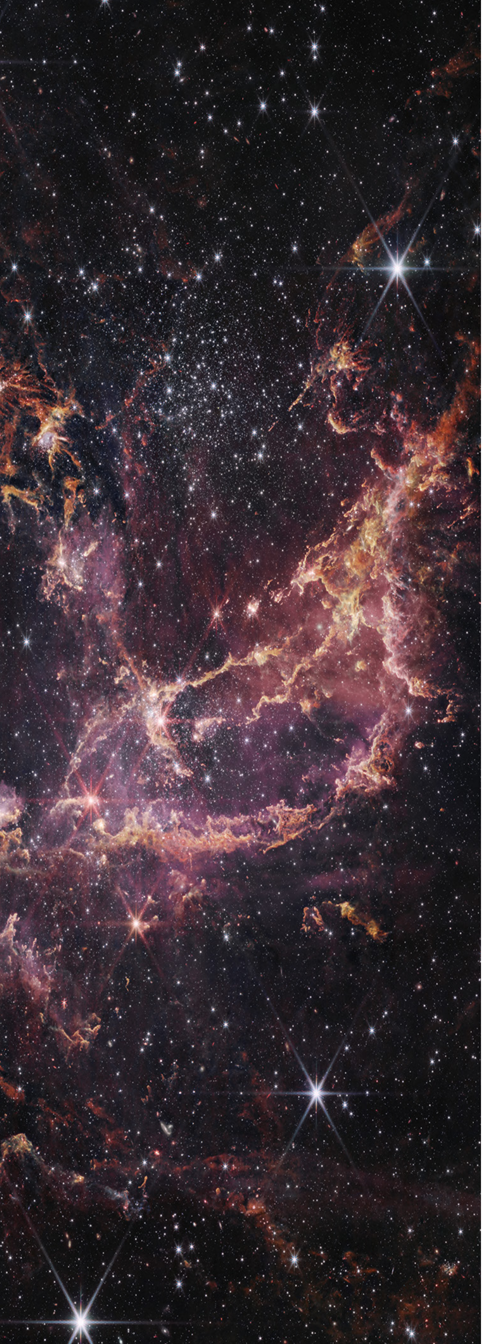
A near-infrared study of the metal-rich globular cluster NGC 6553

Joyce Lin *Carnegie Mellon University moving to University of Wisconsin*
Mentor – *Mario Gennaro (STScI Scientist)*

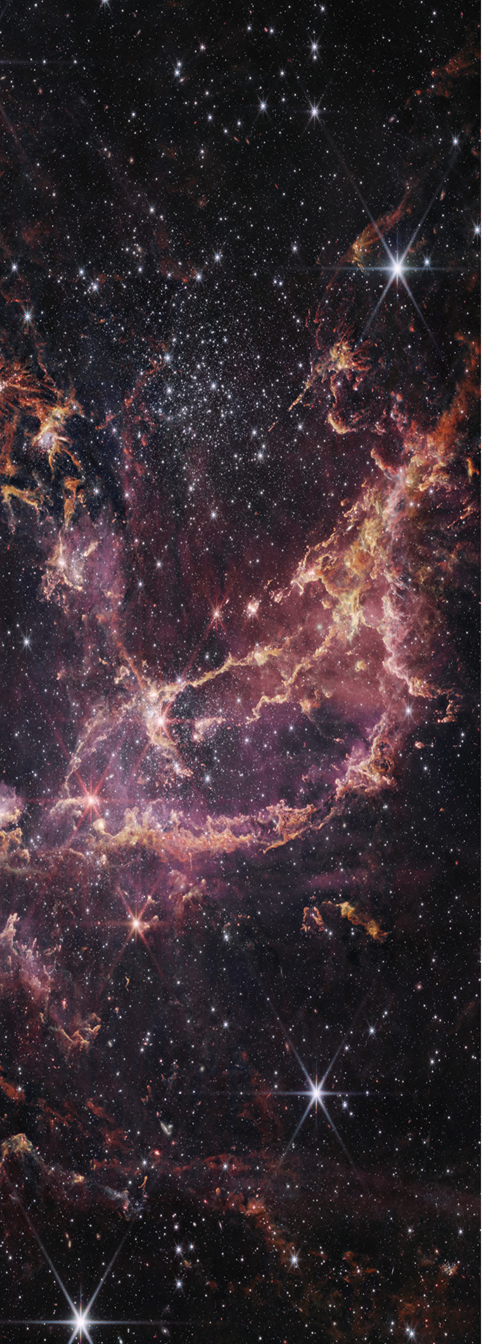
Globular clusters are no longer considered as simple stellar populations. Ground based spectroscopy and HST photometry have revealed a more complex history of their formation and evolution, with multiple populations of different chemical composition. Nevertheless, they remain one of the most important laboratories for testing theories of stellar evolution and they serve as templates for stellar models that are then used in a variety of applications, from the Milky Way to the distant Universe. Of particular interest with the advent of JWST is the study of the lower main sequence of globular cluster, in the near infrared photometric bands. Using the simulation-based, likelihood-free inference code starwave, we studied the properties of the metal rich NGC 6553 cluster using HST/WFC3 infrared data. We first use starwave on synthetic clusters color-magnitude diagrams to assess the accuracy and precision of our retrieval procedure, adopting realistic noise models based on our actual images. We then apply the same technique to the cluster data themselves and measure its age, metallicity, distance, and extinction, in a self-consistent way. Our approach allows a full evaluation of the parameters posterior distributions, including their correlated uncertainties providing valuable information on the relationship between these parameters.



Building a Treasure Detector: towards a quick-look pipeline for JWST NIRISS FGS Guide Star Data

Derod Deal *University of Florida*
Mentor – *Néstor Espinoza*
(Mission Scientist for Exoplanet Science)

Every time JWST observes an object, it simultaneously observes a nearby star --- a so-called “guide star” --- with the Fine Guidance Sensor (FGS) that is used to keep the telescope locked on the target of interest. While researchers typically focus on their science targets, the guide star data can be extremely interesting on its own right. On the one hand, telescope-level anomalies could be detected (and, in principle, corrected) using this guide star data. On the other, this data also provides a “free” sky survey in the infrared (0.6 to 5 microns), on which short (~hours to days) time series of stars are recorded --- which one could “mine” if a pipeline existed for it to search for, e.g., stellar variability or even exoplanet transits: a true treasure detector. Here we present a first version of an automated, public quick-look time-series data processing pipeline for FGS/NIRISS data. The pipeline is able to generate time-series for several metrics of the FGS data in an automated fashion, including fluxes and PSF variations, along with derived products from those such as periodograms that can aid on their analysis given only a JWST program ID number. We present preliminary analyses on a handful of the longest FGS time series to date, highlighting some of the properties of the data, how it can help JWST users and the prospects of using this data to search for astrophysical signals in the archive.



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3D characterization of the ionized gas properties of galaxies in dense structures after the cosmic noon

Kyla Mullaney *University of Chicago*
Mentor – *Valentina Abril-Melgarejo*
(Postdoctoral Researcher at STScI)
Co-Mentor – *Logan Jones*
(Postdoctoral Researcher at STScI)

Galaxies form and evolve in different environments, arranged at large scales, in structures shaped by the distribution of dark matter halos, like filaments, walls, clusters and voids in what is known as the cosmic web. Dense environments are wild places where interactions among galaxies and with their environment lead to structural transformations and a reduction of their gas content (fuel to form new stars). The aim of this project is to characterize some properties of the ionized gas, including the ionization factor and ionization origin diagnostics, and to perform indirect methods to estimate lower limits of chemical abundances. We analyze both the integrated and spatially resolved spectra of star-forming galaxies in a small group of galaxies at intermediate redshift ($z \sim 0.35$). To perform this study, we use Integral Field spectroscopy (IFS) data from the instrument MUSE (Multi-Unit Spectrograph Explorer), covering 1arcmin^2 in the HST COSMOS field targeting 128 objects, from which 10 are part of the galaxy group. The primary sample is composed of 3 star-forming galaxies with spatially resolved IFU observations that include an extended ionized disk and thus are suitable for use in building physical property maps. We retrieve flux and dynamical maps of different elements like O, N, H and S by modeling the emission nebular lines in a spaxel-by-spaxel approach, achieving a spatially resolved characterization of the ionized gas residing in the interstellar medium (ISM) of the galaxies in the sample. In the future, this project has the potential to determine the impact of environment in the distribution of metals in galaxies at different density fields, by comparing our results with those for isolated galaxies in the same dataset.

For further information:
http://www.stsci.edu/opportunities/space-astronomy-summer-program

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TARANTULA NEBULA (NIRCAM IMAGE)