Exploring "Dead and Dying" Galaxies through a Radio Lens

Understanding the different processes by which a galaxy goes from a vibrant star-forming blue spiral to a quiescent ellipsoidal galaxy devoid of new stars remains one of the most important outstanding questions in galaxy evolution. The Shocked POst-Starburst Galaxy Survey (SPOGS; www.spogs.org) seeks to answer that question by pinpointing those galaxies on the brink of this transition. The radio sky in particular is able to shed new light on this problem, specifically in understanding the role that supermassive black holes play in this transition.

Over the summer, the student will compile and look at publicly available Very Large Array (VLA) images and fluxes for these special galaxies to answer some of the following questions: is there something special about the galaxies with radio detections in this sample? Can we tell whether the radio flux originates from an active galactic nucleus or something else? Does the amount of radio emission we see depend on the galaxy's mass, the age of its last starburst, or its environment?

The student will work with members of the SPOGS team on these questions, using the already-existing catalogs for these analyses, which is expected to lead to at least a co-authorship on a scholarly article to be published on the radio properties of this sample.

Astronomy Public Outreach: Illuminated Universe and Social Media

The Illuminated Universe and Social Media intern will work with communication specialists and astronomers in the Office of Public Outreach (OPO) to develop outreach content aimed at meeting STScI's strategic goal of "making the world's astronomy accessible to all."

The internship will consist of two main projects: (a) Migrating content from the old Hubble Heritage website and preparing it for publication on the Illuminated Universe blog; and (b) Writing content to be posted on OPO's social media channels (Facebook, Twitter, and Instagram).

Successful participation in this internship would provide the student with the following:

Insight into the goals and processes of science communication and how science is translated for the general public (e.g., defining objectives, identifying the audience, brainstorming, drafting, reviewing, revising, publishing; writing to spec; collaborating with designers); familiarity with the history and science of the Hubble Space Telescope; increase in basic knowledge of concepts and methods in astronomy; one-on-one mentoring in science writing; a portfolio of writing that will be published online within the following year on the Illuminated Universe blog; experience drafting, revising, and finalizing a presentation abstract and giving a talk about the work.

Simulating HST/COS target acquisitions

The Hubble Space Telescope Cosmic Origins Spectrograph (HST/COS) is the only existing spectrograph that covers the far ultraviolet (FUV) region down to 900 Angstroms, and also contains a channel covering near ultraviolet (NUV) wavelengths. It is extensively used by the astronomy community to characterize a variety of targets, ranging from comets to planets, stars, and galaxies. Target acquisition with COS is performed either via NUV imaging or by using dispersed light data obtained in either channel.

All the acquisition methods are optimized for point sources, and the behavior in case of extended targets is difficult to predict, since it depends on the exact light distribution of the source. Users observing extended sources are currently suggested to perform off-set acquisitions, using suitable stars near the science targets; however, this option is not always viable. The COS team would therefore like to develop a target acquisition simulation tool in order to help users navigate nonstandard target acquisitions with COS.

The summer project involves developing a Python simulation tool that reproduces the exact operations and algorithms performed by the onboard flight software (FSW) during the NUV imaging acquisition and the NUV/FUV dispersed light acquisition. The COS team has several IDL routines currently used to analyze target acquisition data, which will be used as a starting point for the project. The tool will be tested using existing data, and represents the first step toward building a comprehensive target acquisition simulator. The project will involve significant software development in Python, understanding acquisition procedures and algorithms, manipulation of FITS files, implementation of user tests, and writing documentation.

Data Visualization for the WFC3 Quicklook Project

Hubble's Wide Field Camera 3 (WFC3) has one of the largest image collections of any Hubble instrument, but we lack useful ways to explore and visualize the data at our fingertips. Using the MySQL database at the backend of the WFC3 Quicklook project, we could create interesting tools to explore the breadth of WFC3 data. Examples include: a sky map of every WFC3 observation; a plot or graphic of how demands on filters or modes is changing with time (and perhaps whether or not that correlates with instrument performance); or a look at the breakdown of WFC3 proposals by subject.

Furthermore, a similar project is under development for the James Webb Quicklook project, which not only suggests this could be a great tool, but that we may be able to have examples, resources, and collaborative opportunities for the intern with JWQL. The intern would get the chance to learn Python, open source software practices and git, SQL and database applications, web development (including intro level JavaScript and CSS), interactive plotting, and data visualization techniques and theories.

Photometry and Spectroscopy of Supernovae

Despite the vast amount of data that exist for supernova explosions, a number of questions still remain. Specifically, the type of progenitor stars that explode are mostly unknown. Furthermore, new types of supernovae tend to be discovered each year. For this project, a student will go through existing, unpublished archival data from several ground-based telescopes to create a database for review. Next, the student will need to develop a tool (preferably in Python) to both analyze and plot the data for comparison. Interesting discoveries will ultimately be written into a paper. This work will overlap with some James Webb Space Telescope (JWST) mission objectives of developing analysis tools. The student will participate in related JWST meetings.

Wd2db: a toolkit for time series photometry access, visualization and analysis for the young massive cluster Westerlund 2

During the 2017 SASP program, our team developed a database and a server application providing web-based access for a collection of heterogeneous data for the Orion Nebula Cluster (ONC), resulting in the website: https://onc.stsci.edu/. In 2019 we plan to expand the functionalities available within this toolkit, focusing in particular on enabling analysis and visualization for time-domain photometry. The ideal data set is provided by 14807, 15362 and 15514 HST GO programs (PI: E. Sabbi), that together consist in 45 epochs of observations of the young massive cluster Westerlund 2, using the UVIS channel of the Wide Field Camera 3 (WFC3). The WFC3 observations span about 3 years and are taken at variable cadence. Westerlund 2 displays a wealth of variable objects, encompassing single variable stars, eclipsing binaries, ellipsoidal variables and more. Additional earlier-epochs Hubble Advanced Camera for Surveys (HST/ACS) data exist in the archive, that combined with the WFC3 data may allow measure of proper motions.

The summer intern will first familiarize themselves with the dataset and observational strategy. They will then start ingesting the data in a new database using the framework developed for the ONC database. The next stage will consist of integrating new tools for time-series data visualization (e.g. simple phase-folded diagrams, diagrams of magnitudes vs. time). The last part of the project will involve adapting existing tools and algorithms (e.g. lomb-scargle periodograms) to be easily used within the database framework.

Applying Optimization Tools to HST Scheduling

The SPIKE planning and scheduling system uses artificial intelligence based heuristic algorithms to create long-range plans for Hubble Space Telescope (HST) science observations. The intern will examine whether precise numeric solutions can be found to HST scheduling problems. The intern will work with the SPIKE team to extract scheduling problems from SPIKE data, create numeric encodings of the problems, and use off the shelf numeric solvers to determine optimal solutions for the encodings.

Simulating JWST Observations of Transiting Exoplanets

MIRaGe is a Python package developed at STScI that is used to simulate NIRCam, NIRISS, and FGS instrument data. One of MIRaGe's newest capabilities is the creation of Time Series Observation (TSO) data. Typically, these long-duration observations monitor the brightness of a source to search for variations over time. One of the most common use cases for TSOs in the JWST mission will be monitoring for exoplanet transits. This project will involve using MIRaGe to create TSO datasets that can be used to test the JWST calibration pipeline as well as TSO analysis software.

Identifying TESS Flares Using Citizen Science

The student will use Zooniverse to create a citizen science user interface to allow people to identify flares within TESS (Transiting Exoplanet Survey Satellite) light curves. The student will combine their astronomy, interface design, data plotting, and science communication skills for this project. By the end of this project, the student will aim to have a working, interactive tool and the first set of identified flares from nearby stars.

WFC3 DASH Reduction Pipeline Development and Launch

Hubble's Wide Field Camera 3, infrared channel (WFC3/IR) is a powerful instrument that has a field of view which makes it difficult to observe large areas of sky. However, a newly tested observing technique—drift and shift (DASH)—now allows users to take data that covers much larger fields. However, this new method introduces challenges in reducing and analyzing data. This summer project involves developing a flexible software package that will allow users to reduce and analyze their data taken with the DASH mode. The work completed by the student will heavily involve software development in Python, exploration of WFC3/IR observations spanning several different science cases, implementing software and user tests, writing documentation, and creating a tutorial for users.

Massive Star formation in the Large Magellanic Cloud

Massive stars are the beacons of star forming galaxies in the universe, especially at the peak epoch of star formation. However, the formation process for massive stars is poorly understood because they are rare. We are studying the process of massive star formation in the Large Magellanic Cloud. The metallicity of the Large Magellanic Cloud is closer to that of the metallicity at the peak star formation epoch in the universe. The Atacama Large Millimeter Array (ALMA) has been collecting amazing data on the Large Magellanic Cloud. The summer student will learn to work with ALMA data and measure the properties of four giant molecular clouds that contain massive star formation.

Spatially-resolved dust maps of z~1 galaxies

Understanding the distribution of dust in high-redshift galaxies is crucial for determining their rates of star formation, constraining their growth and evolution across cosmic time and comparing them with numerical simulations. We will use resolved emission line maps available for the first time from the CLEAR project in both the H\alpha and H\beta to construct attenuation maps for a set of galaxies in the GOODS-N and GOODS-S fields. We will use the attenuation-corrected emission line maps to create high-quality star formation rate maps. We will use these maps to explore the co-evolution of dust and stellar mass growth in galaxies. All of the data products needed for this project are available.

Adaptation of Spectral Cube Fitting Software for Spitzer and JWST Studies of Active Galaxies

Integral field spectroscopy with the James Webb Space Telescope (JWST) will reveal the impact of supermassive black hole feedback on the interstellar medium and galactic star formation over a wide range of cosmic history. The summer student will convert existing spectral fitting software written in IDL to Python in order to fit the spectral cubes of active galaxies. This will ultimately allow us to integrate these tools with the suite of Python data analysis and visualization tools being developed for JWST at STScI. At the same time, the student will gain experience analyzing spectral cubes observed with the Spitzer Space Telescope with the existing IDL tool. Analysis of the nearby active galaxy NGC 4258 has revealed strong H2 emission in regions heated by the relativistic radio jet, and we want to search for more examples of this phenomenon in archival Spitzer observations.

Outreach Opportunities in Optics

The Space Telescope Science Institute (STScI) performs outreach events to make astronomy exciting, engaging, understandable, and relevant. The intern will create, test, and modify activities to help us meet these objectives. The intern will learn current outreach activities, help deliver them at public events, and document those activities in a consistent format. The intern will adapt and test an activity, originally developed to share optics and coronagraphy with astronomers, for a range of audiences and abilities, and generate a list of potential new outreach activities centered around optics. If progress occurs quickly enough, the intern will be able to create additional new outreach activities in full. To accomplish this work, the intern will work with STScI's Russell B. Makidon Optics Laboratory to learn applicable science, in addition to coordinating with the Office of Public Outreach.

Accessible Space Telescope Schedules

The student will create tools that allow scientists and the public to utilize space telescope schedules effectively. We expect this will take the form of a robust, documented, publicly available API which will provide easy access to current and historical telescope schedules. This will be paired with well-documented, open source examples utilizing the API. The intern would be an integral part of a web development team, utilizing the full software development life-cycle (from requirements gathering to development, deployment, and possibly community growth). They may focus on the back-end (API creation in Rails 5.x), front-end (small apps, written in a modern JavaScript framework, that utilize the API), or both.

Galaxy Formation over Cosmic Time: Bridging Simulations with Observations

When and how galaxies acquire their shapes is one of the most important unsolved questions in astrophysics. Our group uses hydrodynamical simulations to understand the formation and evolution of galaxies over cosmic time. We create synthetic observations of the simulations to compare with observations of real galaxies from the Hubble Space Telescope (HST) and to make predictions for the James Webb Space Telescope (JWST). The student will contribute to the ongoing analysis of the simulations and the synthetic data.