Proposal Category: AR
Scientific Category: Stellar Physics and Stellar Types
ID: 17024
Program Title: Feeling Blue: Creating an Industry Standard SALT3 Model that is Robust at UV Wavelengths

Principal Investigator: Pierel, Justin

PI Institution: Space Telescope Science Institute

Virtually all upcoming cosmological analyses leveraging the several hundred thousand Type Ia supernovae (SNIa) expected from the Vera C. Rubin Observatory and Roman Space Telescope (Zhan+2018; Hounsell+2018) will include the widely used SALT3 light curve fitter. Unfortunately, SALT3 is very poorly trained in the ultraviolet (UV; <3,500A) due to a lack of well-calibrated spectra used to constrain UV spectral features. The atmosphere absorbs ~100% of UV light <3,000A, which means the (primarily ground-based) SALT3 training sample at these wavelengths is comprised of only 85 SNIa spectra that cover just half of the rest-frame model phase range with a median S/N of ~1.4. Over 50% of these spectra are at z>0.4, also leaving SALT3 susceptible to a redshift-evolving bias. The extremely unreliable result has not been a major barrier due to a relative lack of new rest-frame UV observations, but reliably fitting ~35% of all Roman SNIa observations will require SALT3 to be robust below 3,500A. The HST archive now contains 179 STIS G230L and G430L spectra not in the SALT3 training sample from 26 bright, nearby (median z ~ 0.005) SNIa. These unique spectra provide continuous, high-precision, well-calibrated rest-frame UV information from 1,700-5,500A for ~85% of the SALT3 phase range, enabling a 300A extension to the model and drastic improvements in the 2,000-3,500A wavelength range. This proposal triples the UV spectral SALT3 training sample (with double the S/N), quantifies or excludes any redshift-evolution of SNIa in the UV impacting distance measurements at >3sigma, and increases the percentage of reliably fit Roman SNIa data from the current ~66% to ~99%.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17025
Program Title: Extending the Legacy of HST Observations of M dwarfs: Coupled Models of Terrestrial Planet Thermal Evolution and Atmosphere Loss

Principal Investigator: Morley, Caroline

PI Institution: University of Texas at Austin

A vast amount--over 700 orbits--of Hubble time has been dedicated to characterizing the high energy radiation from M dwarfs over their lifetimes; one key goal is to understand exoplanet environments. The smallest M dwarfs are very different from Sun-like stars, with long pre-main sequence lifetimes and a higher fraction of their bolometric luminosity emitted at UV and X-ray wavelengths. Of critical importance to the next era of exoplanet science is connecting what we have learned from this vast library of HST spectra to the physics of planets themselves. Perhaps the highest impact observations in the first cycles of JWST will be the first measurements of planetary atmospheres around terrestrial planets, which are accessible only for planets orbiting the smallest stars. These atmospheres will be shaped by outgassing from the planet and atmospheric escape over billions of years. We propose a two-part effort: first, we will use archival HST UV spectra and X-ray data of 0.1-0.25 M_sun stars to model the high energy emission, creating reconstructed spectra of the currently-unobservable extreme ultraviolet (EUV). Next, we will use these reconstructed spectra as inputs to our atmospheric escape model for terrestrial planets, coupling the atmospheric escape driven by irradiation from the host star and the thermal emission of the planet, which controls outgassing rates. We will focus first on the atmospheres most amenable to JWST observations: warm Venus-like planets with CO2 atmospheres. We will digest the results of our models for observers, providing descriptions of which planets are most likely to have atmospheres and where new UV observations are most needed.

Proposal Category: AR
Scientific Category: Galaxies
ID: 17026
Program Title: The Local Group legacy database of HST photometry

Principal Investigator: Savino, Alessandro

PI Institution: University of California - Berkeley

We propose to uniformly reduce and analyze all ACS and WFC3 imaging that has targeted Local Group dwarf galaxies over the past ~20 years. Though over >1000 orbits of HST have been dedicated to LG dwarf galaxies during this time, <5% of this rich dataset is in the form of high-level science products (i.e., photometry and artificial star tests) that are publicly available. Our sample totals 1540 orbits that target 64 galaxies. This legacy archival program will produce and publicly release uniformly calibrated, time-stamped, multi-band photometry for ~10^6 resolved stars and tens of millions of artificial star tests that are required to characterize uncertainties in the data. This legacy dataset will enable community-based studies of variable stars, star formation, stellar archaeology, stellar evolution, near-field cosmology, and much more. As part of a targeted science component, we will measure, analyze, and publicly release homogeneous star formation histories and update distances to all galaxies using newly available Gaia parallaxes to metal-poor RR Lyrae in the MW. The products from this program will provide the broader community easy access to a large volume of scientifically rich and diverse data that HST has generated for LG dwarf galaxies over its lifetime.

Proposal Category: AR
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17027
Program Title: Thermal properties of the IGM and CGM: Confronting simulations with observations

Principal Investigator: Kim, Tae-Sun

PI Institution: University of Wisconsin - Madison

The circumgalactic medium (CGM) around galaxies is the place where inflows from the intergalactic medium (IGM) and outflows from galaxies interact. Cosmological simulations have predicted that 1) due to the ionizing extragalactic UV background, the low-density IGM has a minimum temperature, which is positively correlated with density and 2) in the higher density CGM, metal-line cooling is balanced by heating from gravitational shocks and galactic feedback, which results in a minimum temperature that anti-correlates with density. As a result of the Hubble expansion, the turnover separating the IGM from the CGM is dependent on redshift. The existence of a minimum temperature strongly influences the manner in which fresh gas accretes onto galaxies, controlling star formation efficiency and mediating galaxy evolution. We propose to observationally determine the minimum temperature of the cool IGM and CGM at z=0-0.5. Observationally, the minimum linewidth and the column density of H I can be used as a proxy for a minimum temperature and density. From a consistent Voigt profile fitting analysis, we will measure linewidths and column densities of about 16,000 H I absorption lines in about 550 COS archival AGN spectra at log N(H I)=13-17, sampling the IGM and the outer CGM at z=0-0.5. From this large, well-defined dataset, we will (1) determine the turnover density and the CGM temperature-density relation and compare them with predictions; (2) estimate the implied sizes of the CGM and (3) trace the evolution of the IGM and CGM by combining the proposed low-redshift measurement with observations at z=2.4.

Proposal Category: AR
Scientific Category: Galaxies
ID: 17028
Program Title: Direct and Indirect Population III Star Formation in Cosmological Simulations of Dwarf Galaxies

Principal Investigator: Schauer, Anna

PI Institution: University of Texas at Austin

We propose to implement Population III star formation into the FIRE simulation project to (i) understand its effect on dwarf galaxies across cosmic history and (ii) publicly provide a physically-motivated prescription for the initial metallicity adopted in general cosmological simulations without direct Population III physics. A primary goal of HST, and eventually JWST, is to understand the formation and fate of the first galaxies and the stars they are composed of. This includes Population III (metal-free) stars, which have been studied extensively in high-redshift simulations. However, connections between Population III stars and the low-redshift Universe are crucial to consider, as metal enrichment from the first stars might be the origin of one of the few glaring mismatches between observations and simulations of ultra-faint dwarf galaxies: observed dwarf galaxies all have [Fe/H] > -3, whereas simulated ultra-faint dwarfs often form with the (much lower) lowest metallicity possible in a simulation (which is put in by hand). We will perform cosmological simulations of ultra-faint dwarf galaxies to trace the effects of the first stars from initial conditions to redshift z=0. With the results, we will directly study the impact of Population III star formation on dwarf galaxy properties as a function of time. We will investigate how metals from the first stars enrich the IGM of dwarf galaxies and how this is reflected in subsequent generations of star formation. This program will enable more detailed comparisons between modern galaxy formation simulations that include all generations of star formation and forefront HST science in both the near field and in deep fields.

Proposal Category: AR
Scientific Category: Galaxies
ID: 17029
Program Title: Extending HST's Astrometric Reach: 3-D Velocities of Satellites of the Andromeda Galaxy from Archival Observations

Principal Investigator: Casetti, Dana

PI Institution: Southern Connecticut State University

HST proper-motion determinations of the Milky Way's dwarf galaxies have proven to be extremely useful in understanding our own Galaxy and the 3D dynamics of its satellite system. We propose to extend the astrometric reach of HST to the satellite system of the Andromeda galaxy. Specifically, we propose to measure the absolute proper motions of six satellites of the Andromeda galaxy using existing, archived exposures that span ~20 years. Such an unprecedented HST time baseline is achieved by combining images taken with WFPC2 and ACS/WFC. To realize the full potential of these data we will take advantage of a recently completed astrometric re-calibration of WFPC2 as well as the most recent updates to the ACS/WFC calibration. The expected accuracy of each satellite's tangential velocity is 40 km/s. Upon completion of the project, our sample will double the number of Andromeda satellites with well-measured proper motions, once these are added to the results of a separate (currently active) HST observing proposal. We will also analyze the orbital information provided by the sample of Andromeda satellites with known 3D velocities, as this sample grows. Andromeda represents the only feasible opportunity for obtaining 3D velocities and performing such a study for a system beyond that of our own Milky Way. We will directly test very specific models for the formation of the Great Plane of Andromeda. We will also compare satellite orbit statistics of the Andromeda and the Milky Way systems in an effort to understand puzzling observational aspects that are not seen in state-of-the-art cosmological models.

Proposal Category: AR
Scientific Category: Solar System Astronomy
ID: 17030
Program Title: Archival Observations of Asteroid Bennu

Principal Investigator: Jewitt, David

PI Institution: University of California - Los Angeles

We propose a detailed analysis of archived HST data from GO 13118, in order to study the ultra-faint particle trail from asteroid Bennu. The ejection of centimeter sized particles from Bennu was one of the major surprises from NASA's OSIRIS-REx mission and established this object as one of the Active Asteroids. The cause of particle ejection is not yet well established. Data obtained for another purpose in 2012 show evidence for an ultra-faint, narrow particle trail that likely corresponds to the summed emission from Bennu over months. We aim to optimally combine 80 images from GO 13118 and measure and model the trail to the full extent allowed by the data.

Proposal Category: AR
Scientific Category: Solar System Astronomy
ID: 17031
Program Title: Investigating Sulfur Abundances and Distributions in UV Comet Observations

Principal Investigator: Noonan, John

PI Institution: Auburn University

A current major problem in astrophysics is the depletion of sulfur in molecular clouds, protostellar cores, and protoplanetary disks relative to cosmic abundances. In contrast, comets appear to have atomic sulfur abundances that are larger than expected given the observed sulfur-bearing parent molecules. Mapping the sulfur chemistry of comets and characterizing trends between the two dynamical classes, isotropic and Jupiter family comets, are essentially to our understanding of astrophysical sulfur chemistry. We request Legacy Archival Research funding over three years to determine for the first time the elemental abundance and sulfur chemistry of the entire UV sample of 1514 observations of 78 comets, obtained in 104 programs by the Hubble Space Telescope and International Ultraviolet Explorer, obtained from the Mikulski Archive for Space Telescopes. To execute this program, we will 1) recalibrate, re-extract, and re-reduce UV cometary spectra containing atomic sulfur and sulfur-bearing molecular emissions; 2) interpret the observed emission intensities with Monte Carlo distribution and radiative transfer models; and 3) report the the derived column densities, production rates, and relative abundances of atomic sulfur and relevant sulfur-bearing molecules. This exhaustive re-calibration and re-analysis of the UV comet dataset will fundamentally change our understanding of cometary atomic sulfur abundances and parent molecules and provide critical information to the larger astrophysical question about sulfur's hiding place in molecular clouds, protostellar cores, and protoplanetary disks.

Proposal Category: AR
Scientific Category: Galaxies
ID: 17032
Program Title: An Archival Far-Ultraviolet Legacy Survey of the GOODS and COSMOS Fields: Completing the Census of the UV Sky

Principal Investigator: Siana, Brian

PI Institution: University of California - Riverside

Over the past 15 years, 365 orbits of deep, far-UV (1600 A) imaging have been obtained in 151 pointings with the ACS Solar Blind Channel (SBC) in the GOODS and COSMOS legacy extragalactic fields. The images cover ~45 sq. arcmin. to FUV=28-29.8 (AB, 3 sigma, 0.5" radius, exposure times vary) and provide high resolution far-UV imaging of galaxies at z<0.75. Reduced images have been made public for only 21% of orbits (78/365) and 26% of pointings (39/151). Legacy archival HST programs have been awarded to compile all near-UV, optical, and near-IR HST imaging in these fields. We propose to complete the HST legacy by reducing all SBC far-UV images in these fields, map them to existing archival images, and provide images & catalogs. We expect ~1000 detected galaxies at 0.2<z<0.9. The data products will enable many studies including Lyman Continuum escape at z~1.2-1.5, resolved dust maps, bursty star formation, and star-forming clump sizes. We will measure far-UV number counts down to AB=29.8 in three independent fields, with 2.8x the area of previous counts, decreasing total uncertainty in the UV extragalactic background light (EBL) by a factor of ~3 (from ~21% to ~7%), bringing it better in line with estimates from funded archival programs to determine the EBL at all other HST wavelengths. This will help inform a current tension between direct EBL measurements (via New Horizons) and those from integrated counts. With photo-zs, we will also model the evolution of the UV EBL. This will be the definitive result for the foreseeable future and will strongly constrain various aspects of galaxy evolution and acurately correct for gamma-ray attenuation of NASA Fermi sources.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17033
Program Title: Probing Omega Cen's Stellar Mass Black Hole Population Through Microlensing

Principal Investigator: Seth, Anil

PI Institution: University of Utah

Massive star clusters are a primary candidate for hosting the binary black hole mergers observed using gravitational waves. This is due to theoretical expectations that massive clusters can retain large numbers of stellar mass black holes, which then sink to the center of the cluster and form a steady supply of binary systems. However, only a handful of black holes have been detected in clusters, and there is no direct evidence that clusters host large numbers of them in their cores. Omega Centauri is the most massive star cluster in the Milky Way and indirect dynamical evidence suggests it hosts tens of thousands of stellar mass black holes in its core. A recent paper has estimated that these black holes should create detectable microlensing events every 1-10 years. Here we propose a search for black hole microlensing events in Omega Cen using nearly 600 archival observations of the central regions of the cluster over the past 12 years. Based on existing rate estimates, which appear to be conservative, we expect to detect 1-2 black hole microlensing events. Thus, this proposal will likely result in the first black hole detected in Omega Cen and the first microlensing detection of a black hole in a star cluster. We will also improve theoretical rate estimatesto translate any detections (or a non-detection) into constraints on the total mass and radius of the stellar mass black holes in Omega Cen.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17034
Program Title: Photometric search for Black Hole-Star Binaries in the Milky Way Galactic center

Principal Investigator: Gautam, Abhimat

PI Institution: University of California - Los Angeles

Galactic nuclei have been proposed to produce the types of binary black hole mergers that have recently been detected by gravitational wave observatories. Tight black hole-star binary systems are likely precursors to these mergers. However, the number of tight black hole-star binaries in galactic nuclei is not yet well constrained. The Milky Way Galactic center, being the only Galactic nucleus with individually resolvable stars, allows constraining the presence of black hole-star binary systems in galactic nuclei and evaluating if they indeed are likely factories of binary black hole mergers observed with gravitational waves. We propose to use 9.7 years of archival HST-WFC3IR observations of the central 5 parsecs of the Galactic center to photometrically search for and characterize stellar-mass black holes in close binary systems. We will use the multi-epoch observations to search for variability consistent with ellipsoidal effects and Doppler beaming expected in close binary systems with compact components. Using preliminary simulations based on the binary fraction and stellar-mass black hole production rates for the young and old stellar populations of the Galactic center, we predict that our experiment should detect 1 to 6 close binary systems possesing stellar-mass black holes. In detected systems, we will model the flux variability to constrain compact object masses. Our proposed experiment can detect stellar-mass black holes in detached binary systems at the Galactic center, and constrain the viability of galactic nuclei to produce the recent binary black hole mergers observed by gravitational wave observatories.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17035
Program Title: The Great Escape: A comparative study of photoevaporation in exoplanets observed with HST

Principal Investigator: Dos Santos, Leonardo

PI Institution: Space Telescope Science Institute

We propose to adapt an existing modeling framework to interpret ultraviolet observations of atmospheric escape in exoplanets, aiming to provide the community with a scalable, open-source code that will be used to understand the evolution of exoplanets at the population level. Our motivation lies in that understanding the complex evolution of planetary atmospheres and how they respond to a changing space environment is a critical factor in the search for Earth-like worlds. Most of the exoplanets discovered to date orbit extremely close to their host stars, driving their atmospheres to quickly evaporate to space. Recent transmission spectroscopy observations of atmospheric escape in several hot exoplanets have sparked a new wave of theoretical efforts in modeling photoevaporation and its impacts in the evolution of hot gas giants to rocky planets. As more and more observations are executed, we need to develop simplified theoretical frameworks that allow us to effectively probe exoplanet atmospheres as a sample, which in turn allows us to perform comparative studies. The code we propose to develop allows for fast calculations that yield Bayesian estimates of mass loss rates and other properties of the planet's upper atmosphere. HST has already observed more than 10 exoplanets in the UV using the transmission spectroscopy technique, and several other planets are slated to be observed in Cycle 29. At the end of the project, we will leverage these archival and future datasets to uniformly study all observed planets using this new framework, yielding for the first time a comparative study of photoevaporation in exoplanets based on HST data.

Proposal Category: AR
Scientific Category: Stellar Physics and Stellar Types
ID: 17036
Program Title: Sensitive age-activity relations for old main sequence stars: MgII h+k emission beyond 1 Gyr

Principal Investigator: Melis, Carl

PI Institution: University of California - San Diego

We aim to establish a transformational approach to age dating Sun-like main sequence stars with ages greater than roughly 1 Gyr. Verification of the proposed methodology would usher in the ability to obtain accurate age estimates for a large fraction of main sequence stars in the solar neighborhood and many beyond; the scientific applications of such a capability are myriad and include stellar astrophysics, Galactic archaeology, and exoplanet system studies. We will synthesize archival HST and in some cases IUE data to explore age-activity trends for ultraviolet emission. Previous works indicate that chromospheric ultraviolet MgII emission experiences a dramatic drop-off with stellar age for ages greater than roughly 1 Gyr; through this work we will confirm and better characterize this drop-off with stars having well-measured ages. We will assess how robust a MgII age-activity relation is for stars older than roughly 1 Gyr and with what precision it allows one to estimate a stellar age.

Proposal Category: AR
Scientific Category: Galaxies
ID: 17037
Program Title: Constraining star formation with the deepest HST images of M87

Principal Investigator: Sun, Ming

PI Institution: University of Alabama in Huntsville

While AGN feedback has emerged as a key ingredient in galaxy formation and suppressing cooling in X-ray cool cores, heating cannot stop cooling at all times and all spatial scales. Indeed, star formation (SF) is still common in X-ray cool cores around the brightest central galaxies (BCGs). SF in BCGs is the final sink term in the energy balance/transfer in the the multi-phase medium. The relation between radio AGN and SF is an important question in AGN feedback. For strong X-ray cool cores associated with strong radio AGN, besides the studies on ones with strong SF, detailed studies on ones with weak SF is also required for a complete understanding of the feedback cycle. We argue that the closest BCG M87 is the best object for such kind of studies and propose an HST archival study of M87 with the deepest HST data available to any BCG, especially taking advantage of the recently available deep WFC3/UV data. SF indeed happens in M87 but at a low level. These deep HST data, combined with the proximity of M87, present a rare opportunity to study low-level SF in X-ray cool cores, which is impossible in more distant cool cores. Some initial analysis has been finished to reveal a population of UV-bright sources resembling young star clusters. Young star clusters will be identified. Their connection with optical emission-line filaments, soft X-ray clumps, recent AGN shocks and outbursts will be probed. We will constrain the recent star formation history in M87 and link it to the recent history of cooling and AGN outbursts in M87 revealed from the radio and X-ray data. The results will also have general implications for the radio AGN feedback cycles in X-ray cool cores.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17038
Program Title: Testing Feedback Physics in Dwarf Galaxies Using Radial Stellar Population Gradients

Principal Investigator: Cohen, Roger

PI Institution: Rutgers the State University of New Jersey

Because of their low masses and ubiquity, dwarf galaxies serve as crucial probes of a variety of astrophysical processes taking place from reionization to the present day. State-of-the-art cosmological simulations make predictions for radial stellar population gradients within dwarf galaxies based on feedback having a dominant role, but these predictions have never been tested. We propose to use archival HST optical imaging for a diverse sample of 36 nearby (<5 Mpc) dwarfs to derive star formation histories from color-magnitude diagrams, spatially resolved within radial annuli for each target galaxy. Unlike integrated light analyses, this will provide radial profiles of star formation rate, age, and metallicity that are directly and quantitatively comparable to the model predictions, posing a sensitive test of star formation and feedback physics. To maximize our science return, these results will be leveraged together with high-resolution maps of neutral hydrogen, structural properties from Spitzer IRAC imaging, and optical integrated light color profiles, all analyzed self-consistently. This multi-wavelength approach, combined with a diverse sample, allows us to test the following predictions: 1) Galaxies with younger median ages have flattened radial gradients of both stellar age and metallicity. 2) The slopes of radial age and metallicity gradients are uncorrelated with mass or gas-phase metallicity, but have a tight, linear correlation with global galaxy median age. 3) Age and metallicity gradients are insensitive to previous interactions since accreted stars are well-mixed, and feedback remains the dominant driver of the gradients.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17039
Program Title: Optical Counterparts to Ultraluminous X-ray Sources

Principal Investigator: Gallo, Elena

PI Institution: University of Michigan

The nature of extragalactic ultraluminous X-ray sources - exceeding the Eddington limit for a 10 solar mass compact object - remains enigmatic. Historically, the debate around what powers ULXs has revolved around genuinely massive black holes or super-Eddington accretion onto stellar-sized black hole. However, the recent discovery that some of these systems host pulsating neutron stars has shuttered long-held views. Following the release of a comprehensive ULX catalog, we propose a systematic search for optical counterparts to over 300 ULXs in 120 host galaxies within 20 Mpc; these galaxies have sufficiently deep, multi-band ACS/WFC3 imaging data to pinpoint the stellar counterparts. This is a key first step in the attempt to determine ULX binary parameters, and identify the first dynamically confirmed black hole ULX.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17040
Program Title: A Multi-wavelength Picture of Star Formation in the Fireworks Galaxy

Principal Investigator: Tran, Debby

PI Institution: University of Washington

We will utilize archival Hubble WFC3 and ACS data of star-forming galaxy NGC 6946 (The Fireworks Galaxy) to obtain IR, optical, and UV photometry in 15 bands, perform spectral energy distribution (SED) fits, and constrain temperatures, masses, and ages of over 8 million stars to study global and local star formation. Specifically, we will create resolved luminosity, age, and mass maps of NGC 6946 to analyze age and mass gradients in the spiral arms and obtain the luminosity, age, and mass functions of clusters to constrain spiral arm and star formation models. Additionally, we will constrain the mass-radius relation from the wide-ranging sample of clusters. Using the wealth of archival resolved mutli-wavelength HST WFC3 and ACS photometry of NGC 6946, we will obtain insight into galactic structure formation and evolution and how it relates to resulting stars and clusters in spiral galaxies with active star formation.

Proposal Category: AR
Scientific Category: Galaxies
ID: 17041
Program Title: STRAYCOR: Stray-light background correction for HST ACS and WFC3

Principal Investigator: Serrano Borlaff, Alejandro

PI Institution: NASA Ames Research Center

Despite their advantageous position above the atmosphere, HST ACS and WFC3 detectors are sensitive to a large number of sources of light contamination. Photons that reach the detector out of their intended optical paths (stray-light) generate artificial systematic gradients, increasing the background level, and ultimately limiting of detection of astronomical sources. Standard background correction techniques (i.e., fit & subtract) have proven to be an inefficient solution only suitable for the study of bright, compact sources, while they significantly lead to over-subtraction of the dim, extended emission from galactic halos, intergalactic dust cirrus, tidal tails and the diffuse intracluster light. As a consequence, a significant fraction of HST scientific potential remains undiscovered in the original raw exposures. The proposed project (STRAYCOR) will be focused on the modelling and correction, on a pixel-per-pixel basis, of the stray-light background for ACS and WFC3/IR images. We will generate stray-light models based on the relative position and flux from every source visible from HST including 1) Zodiacal light, the Milky Way interstellar medium, and Extragalactic Background, 2) the emission from stars and Solar System bodies, and 3) extended reflected light from Earth and the Moon. This forward modelling approach will allow correcting artificial gradients, improving the low surface brightness detection capabilities of the Hubble Space Telescope. The proposed methodology will complement and be implemented in two ongoing Hubble Archive Legacy proposals dedicated to the recalibration of HST archival data (SUPERCAL and SKY-SURF).

Proposal Category: AR
Scientific Category: Galaxies
ID: 17042
Program Title: Are Galactic Outflows Seen in Absorption and Emission Lines Tracing the Same Gas?

Principal Investigator: Xu, Xinfeng

PI Institution: The Johns Hopkins University

Galaxy formation is regulated by feedback in the form of galactic outflows, which carry mass, energy, and momentum out of the galaxy's central regions. These outflows are well known through studies of both optical emission lines, and UV absorption lines. However, it remains unclear whether these two observational methods yield a consistent picture of outflows. Therefore, we propose the first-ever joint analysis of outflows observed in optical emission and UV absorption lines for a large sample of UV-bright star-forming (SF) galaxies. We have identified a sample of 29 such galaxies at low-z ($z < 0.26$) with archival spectroscopy from HST/COS and the Keck Echellette Spectrograph and Imager. With the combined data sets, we will make robust measurements of outflow properties, including kinematics, column density, ionization, distance, as well as outflow rates of mass, energy, and momentum. We will quantify any systematic relationships between absorption- and emission-based outflow properties, and answer the essential question: "Do absorption and emission lines probe the same outflowing gas distribution?" Furthermore, we will construct models to explain both outflow measurements consistently, thereby robustly constraining the outflows' density and velocity distributions. In turn, these analyses will improve our understanding of galactic outflows, and lead to more realistic implementations of sub-grid physics in hydrodynamical galaxy formation simulations. Ultimately, by learning how to best leverage the full suite of observational constraints, we will be better able to interpret JWST observations, where emission lines will be the primary tool for measuring outflow properties.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17043
Program Title: Measuring the Absolute Ages of Milky Way Globular Clusters

Principal Investigator: Chaboyer, Brian

PI Institution: Dartmouth College

We propose to develop a new framework for measuring the absolute ages of globular clusters (GCs) and apply it to 7 metal-poor Milky Way (MW) GCs that have deep archival HST imaging. Preliminary calculations indicate that our new analysis techniques will lead to a factor of two reduction in the uncertainty of the ages of the oldest GCs. We will use the results of our analysis to (i) provide novel constraints on the stellar physics of metal-poor stars; (ii) examine the absolute ages of GCs and ultra-faint dwarf galaxies relative to cosmic reionization; and (iii) set a robust, cosmology-independent lower limit on the age of the Universe. The absolute ages of GCs anchor our understanding in a variety of contexts, from the chronology of the MW's formation to the connection between conditions in the interstellar medium and star cluster formation. While uncertainties in absolute ages have been relatively large (~1.5 Gyr or more), recent advances have provided an opportunity to significantly reduce these uncertainties. This will sharpen our view of the formation of star clusters and their connections to open questions in cosmology and galaxy formation. Using a Monte Carlo approach, we will create >10^5 isochrones that sample all relevant stellar physics uncertainties. We will fit the stellar models to the main sequence turnoff (MSTO) region of HST color-magnitude diagrams of 7 clusters. We will measure each cluster's absolute age, marginalized over all uncertainties in other parameters, and quantify how much each parameter contributes to each GC's age uncertainty. We will make all data and analysis products, including new stellar models, available to the community.

Proposal Category: AR
Scientific Category: Galaxies
ID: 17044
Program Title: Galaxy-halo connection from resolved star formation histories of dwarf galaxies

Principal Investigator: Wechsler, Risa

PI Institution: Stanford University

Hubble Space Telescope observations have enabled, for the first time, homogeneous measurements of the star formation histories for most dwarf galaxies in the Local Group (LG) based on resolved stellar populations. In order to fully utilize these measurements to further inform our understanding of the onset of galaxy formation and of dwarf galaxy formation in a full cosmological context, we propose to develop a semi-empirical model that self-consistently matches observed star formation histories of LG galaxies to the assembly history of their dark matter halos over cosmic history. Our approach builds upon the success of the UniverseMachine model, and will implement components for reionization and environmental quenching within multi-resolution simulation suites that enable self-consistent modeling of the full range of masses and redshifts relevant for dwarf galaxies. Our proposed work will provide a constrained distribution of plausible halo assembly histories for each observed LG dwarf galaxy, connect LG measurements to the growing sample of similar galaxies in the Local Volume (~100 Mpc), and enable robust constraints on the onset and progress of galaxy formation in the smallest galaxies in the Universe. All data products including the model itself, dark matter halo assembly histories, and galaxy star formation histories will be made publicly available to the broader astronomy community.

Proposal Category: AR
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17045
Program Title: HST spectroscopy of X-ray ultra-fast outflows

Principal Investigator: Mehdipour, Missagh

PI Institution: Space Telescope Science Institute

We propose an archival research program with HST to investigate the UV spectral signatures of X-ray ultra-fast outflows (UFOs) in active galactic nuclei (AGN). The UFOs, with relativistic outflow velocities, are a crucial component of AGN outflows. These energetic winds have adequate kinetic luminosity to play an important role in AGN-galaxy feedback. There are, however, significant gaps in our understanding of UFOs from X-ray studies alone. High-resolution spectroscopy with HST of potential UV counterparts of X-ray UFOs can provide key additional physical information, such as their kinematics and ionization structure, which cannot be ascertained from the X-rays alone. For this archival study with HST we have selected a sample of suitable AGN, composed of two groups, which have previous reports of UFO detection in X-rays. We aim to investigate the multi-ionization-phase 'entrained UFO' model, which would provide a feasible explanation for the currently uncertain formation and structure of these ionized outflows in AGN, bridging small-scale UFOs to large-scale warm-absorber and molecular outflows.

Proposal Category: AR
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17046
Program Title: Understanding the nature of large radio-optical offsets in ICRF3 sources and exploring the ability to detect dual and dislodged AGNs

Principal Investigator: Schmitt, Henrique

PI Institution: Naval Research Laboratory

We propose an archival project to investigate the origin of large astrometric offsets between the radio and optical positions of the celestial reference frame sources (ICRF3) used to register the Gaia optical celestial reference frame. We selected a subsample of ICRF3 sources with astrometric radio-optical error normalized offsets exceeding 10 standard deviations, and were able to find suitable archival WFPC2, WFC3, ACS and NICMOS images for 85 of them (~30% of the subsample). These observations will be used to investigate the origin of these offsets, and explore the possibility that they are due to dual or dislodged AGNs.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17047
Program Title: Searching for Earths and super-Earths in the inner gas disk

Principal Investigator: Calvet, Nuria

PI Institution: University of Michigan

We propose to analyze the Mg II 2800 doublet lines in 14 stars in the Taurus star-forming region observed in the Disks, Accretion, and Outflows program (DAO, GO11616) to search for evidence of depletion that might be due to the formation of Earths and super-Earths in the innermost gas disks of the targets. The Mg II lines form in the magnetospheric accretion flow in which matter is transferred from the inner disk to the star, and therefore they offer a direct assessment of the gas in the innermost disk. We will estimate the Mg abundance entering the gas disk by modeling the Mg-rich minerals in the silicate features present in the spectral energy distributions of the targets. The comparison of gas and dust abundances will be used to test models of in-situ formation of super-Earths. The Taurus targets are well characterized from the X-rays to the submillimeter and have been used as templates for low mass young populations for decades. The medium resolution observations in the NUV make the DAO sample unique, unmatched by even the legacy program ULLYSES, and allows resolving the Mg II lines for detailed modeling.

Proposal Category: AR
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17048
Program Title: Searching for the Imprints of AGN Feedback on the Ly-alpha Forest Around Massive Quenched Galaxies

Principal Investigator: Khaire, Vikram

PI Institution: Indian Institute of Space Science and Technology

One of the biggest unsolved problems in galaxy formation is the physical mechanism that quenches star formation in massive systems, giving rise to the observed dichotomy between blue star-forming galaxies and red-and-dead ellipticals. In order to reproduce it, all modern cosmological simulations implement some variant of AGN feedback, driving powerful galactic scale outflows that suppress star-formation in massive galaxies at late times. Simulations show that these outflows can expel baryons into the circumgalactic and intergalacticmedia (IGM and CGM) resulting in Mpc-scale bubbles of tenuous hot (T > 10^6 K) gas surrounding massivegalaxies. The degree to which AGN feedback contributes to the number of baryons in the so-called warm-hot intergalactic medium (WHIM), adding to the inevitable contribution from gas shock-heated by structure formation, is at the heart of the long-standing missing baryon problem. We propose to use an archival sample of 94 HST/COS background QSO spectra probing the massive halos hosting 3193 foreground SDSS luminous red galaxies (LRGs; z < 0.5) to statistically characterize the Ly-alpha forest absorption profile at impact parameters from 0.1 to 10 pMpc. By performing an end-to-end feasibility study of our proposed analysis using state-of-the-art cosmological simulations and realistic mock COS spectra, we demonstrate that the abundance of HI Ly-alpha forest lines (N_HI < 10^14 cm^-2) in this dataset provides a precision probe of AGN feedback models and the fraction of baryons in the WHIM.

Proposal Category: AR
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17049
Program Title: Elucidating Galaxy Quenching with Absorption Probes of Halos around Low-mass Dwarfs

Principal Investigator: Polzin, Ava

PI Institution: Yale University

The tension between the observed abundant gas and inefficient star formation in low-mass dwarf galaxies of stellar mass Mstar<1e9 Msun make them a critical population to study in order to better understand the significance of different processes that regulate star formation. This proposed archival program aims to leverage extensive archival data to establish a deeper understanding of the baryon cycle in dwarf galaxies. A sample of 30 low-mass dwarfs outside of the Local Group (LG) with Mstar=1e6-1e9 Msun have been identified within 100 kpc of the sightlines of 42 UV bright background QSOs, for which high-quality archival HST COS FUV spectra are available. Nineteen of these are isolated field dwarfs and 11 are satellites with known luminous neighbors at <1 Mpc. Five of the 19 isolated dwarfs have 2-3 QSO probes within 100 kpc, enabling spatially resolved studies of their halo gas. Archival multi-color HST images are available for 15 of these galaxies, providing additional constraints on their star formation history based on resolved stellar population studies. The proposed dwarf galaxy sample will more than double the number of dwarf galaxies beyond LG with known halo gas properties and provide a crucial window into the behavior of the circumgalactic medium (CGM) around well-characterized dwarf galaxies across environments and a broad mass range. The primary objectives of the proposed archival study are: (1) characterizing the extent and chemical enrichment in the CGM around low-mass dwarf galaxies and (2) differentiating the significance between supernova feedback and environmental processes such as tidal and ram-pressure stripping that drive quenching in low-mass dwarfs.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17050
Program Title: Maximizing the Science Return from HST UV Observations of Transiting Exoplanet Atmospheres

Principal Investigator: Line, Michael

PI Institution: Arizona State University

Spectroscopic characterization of transiting exoplanets with HST has led to a sea of change in our understanding of extra-solar atmospheres, from ultra-hot Jovians to temperate super-Earth worlds. Transmission spectra are sensitive to molecular and atomic absorbers, clouds/hazes, molecular weight, and average temperature at high altitudes along the limbs of the planet. Much of the theoretical and observational focus has been on understanding/interpreting the atmospheric properties that can be informed by optical/near-IR spectra--primarily due to the nominal observing mode/capabilities of HST and Spitzer. However, recent advances in HST observing modes and data processing (e.g., WFC3/UVIS-G280) have enabled simultaneous broadband NUV-to-Optical spectroscopy of transiting planets. However, there has been little theoretical development in understanding just how diagnostic NUV spectra, and their combination with longer wavelengths, can be. NUV spectra, owing to large refractory, gaseous opacities, are thought to be diagnostic of the onset of condensate cloud formation, vertical mixing, and refractory composition in planetary atmospheres. Our proposed theoretical work will develop a foundation for understanding the exoplanet atmospheric processes that benefit from NUV observations. We will develop an atmospheric population synthesis framework, leveraging state-of-the-art radiative convective models, to generate predictive atmospheric process hypotheses that can be tested with NUV observations and directly compared to publish datasets. This theoretical foundation will have implications for over a dozen planets over a dozen NUV HST programs and beyond.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17051
Program Title: A ULLYSES Survey of the Magellanic Clouds: a Laboratory for the Physics of Interfaces between Hot and Cold Gas

Principal Investigator: Lehner, Nicolas

PI Institution: University of Notre Dame

The interface layers between hot and cool gas play a critical role in regulating the physical processes in galaxies and are crucial to theories of galaxy formation and evolution. The high ions OVI, NV, CIV, SiIV are the best probes of these interfaces. Yet their core properties are still poorly constrained because we have little direct observations of their dependence on the physical environments and metallicities. We propose to use the ULLYSES UV spectra of 239 hot stars to produce the first comprehensive analysis of the highly ionized gas in the LMC and SMC galaxies with a metallicity of 0.50 and 0.25 solar. The ULLYSES dataset is uniquely suited for this analysis owing to its uniformly high quality spectra. In addition, there is a wealth of ancillary data in the LMC and SMC, allowing for the characterization of the physical galactic environments at an unprecedented level of detail. Our program will enable the following key science goals: 1) we will characterize unambiguously for the first time the microphysics properties of the highly ionized gas in interface layers; 2) we will determine variations in these properties as a function of galactic environment and metallicity; and 3) we will help interpret low-resolution spectra of high ions in high-redshift objects by creating equivalent spectra by means of stacking and smoothing ULLYSES spectra covering prominent structures. We will release high-level data products, including a new classification scheme of the interstellar environment probed by each ULLYSES LMC/SMC target. Our program will pave a new path to understanding how the highly ionized gas in interface layers shapes galaxies.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17052
Program Title: Quantifying Systematics in the JAGB Method Distance Scale in M31

Principal Investigator: Lee, Abigail

PI Institution: University of Chicago

JAGB stars, a subset of carbon-rich, thermally-pulsating AGB stars, have well-defined, low-dispersion absolute magnitudes in the near infrared, making them excellent standard candles. The JAGB star extragalactic distance indicator has been shown to be on par with the Cepheid and TRGB methods in both precision and accuracy, and therefore capable of acting as a powerful cross-check on SN Ia host galaxy distances. However, because the JAGB method is still relatively novel, it has not been as well tested as the Cepheid and TRGB distance indicators. We propose to leverage archival data from the Panchromatic Hubble Andromeda Treasury (PHAT) in M31 to quantify how the host galaxy star formation history, internal reddening, and metallicity may affect the JAGB method distance scale. The JAGB method has already been shown to be highly precise; understanding the systematics of even these small effects will further increase its precision. Once the potential systematics of the JAGB method have been thoroughly investigated, the JAGB method can be used to provide an independent local measurement of H0, and cross-check TRGB and Cepheid distances. As a bonus, this proposal will help provide observational constraints on the carbon star luminosity function in different stellar environments, directly guiding theoretical models of carbon star evolution which includes winds, dredge-ups, and hot-bottom burning.

Proposal Category: AR
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17053
Program Title: The Cool CGM of the Large Magellanic Cloud

Principal Investigator: Fox, Andrew

PI Institution: Space Telescope Science Institute - ESA

Only 50 kpc away, the Large Magellanic Cloud is the nearest massive galaxy to the Milky Way. This makes the LMC ideally suited for spatially resolving the CGM in UV absorption and probing the physics that governs the production of cool gas in galaxy halos. Existing data show the LMC CGM is complex and multi-phase, with recent work focusing on the existence of a hot (T~10^5.5 K) coronal phase. However, little is known about the origin and properties of diffuse cool (T~10^4 K) gas in the Magellanic CGM. Some of the cool gas is associated with tidal H I structures like the Magellanic Stream, Bridge, and Leading Arm, but other cool clouds are observed in directions far from these structures. In a pilot study, we have determined that the UV low ions around the LMC show a declining radial profile -- a column density that declines with impact parameter out to ~50 kpc - a characteristic signature of a diffuse CGM. Here we propose an archival program to fully characterize the diffuse cool CGM of the LMC in a sample of 28 AGN directions with publicly available HST/COS G130M/G160M spectra. The analysis will use observations of many FUV low ions (O I, C II, Si II, Si III, S II, N I, Al II, Fe II) together with ionization modeling and hydrodynamical simulations to form a comprehensive study of the size, mass, ionization, chemical enrichment, dust depletion, and survivability of the LMC's cool CGM. Altogether, this will allow us to quantitatively assess models of the origin and fate of the cool Magellanic CGM.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17054
Program Title: A Library of Extreme Ultraviolet Spectra for 115 Main-Sequence Stars to Enable Comparative Exoplanet Studies

Principal Investigator: Duvvuri, Girish

PI Institution: University of Colorado at Boulder

The extreme ultraviolet (EUV) emission from stars is the dominant source of heating to the upper atmospheres of planets and drives atmospheric escape, but this wavelength regime is unobserved for most exoplanet host stars. The differential emission measure technique is a method to infer the EUV emission of stars using FUV emission lines and X-ray fluxes as inputs. This method can function in the limits of low precision data with appropriately propagated uncertainties and can be effectively applied to a large ensemble of stars. We will use archival Hubble STIS/COS data of 115 GKM dwarfs, supplemented by archival X-ray data, to infer these stars' EUV spectra using the differential emission measure technique. The selected sample spans a wide range of stellar masses and ages encompassing a parameter space that includes the vast majority of exoplanet hosts. The EUV spectral library of this sample will be published in an easy-to-use format for the broader exoplanet community to use as inputs for models of planetary atmosphere formation and evolution and to study the present-day EUV irradiation of known exoplanets. To make statistically and scientifically rigorous claims about the relationship between EUV emission of planet hosts and the properties of their planetary systems we need population-wide EUV estimates with well-characterized uncertainties. This proposal makes use of the Hubble archive to provide homogeneously determined EUV spectra, enabling comparative studies of exoplanets formation, evolution, and habitability.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17055
Program Title: Photometric Abundance Measurements in Globular Clusters

Principal Investigator: Bailin, Jeremy

PI Institution: University of Alabama

Elemental abundance variations in globular clusters are universal but not well understood. HST photometry has been instrumental in detecting these populations, but does not directly provide the underlying elemental abundances, which are the physical property that can be compared to theoretical models; those measurements come from spectroscopic data for which it is very difficult to obtain large samples. We propose to combine literature spectroscopic measurements of O, Na, and Fe abundances of red giants with archival HST photometry of the same stars spanning 57 globular clusters. We will use this combined data set to train a machine learning regression model to predict the abundances for the vast majority of red giants in the HST data without spectroscopic measurements, and use them to build full elemental distribution functions and chemospatial maps of the clusters.

Proposal Category: AR
Scientific Category: Galaxies
ID: 17056
Program Title: Creating a Standardized Sample of Milky Way Satellite Galaxy Binary Fraction Measurements

Principal Investigator: Strigari, Louis

PI Institution: Texas A & M University

Binary star systems are a natural by-product of star formation and evolution. While binaries are likely common throughout the universe, statistically quantifying the fraction of stars residing in binary systems has proven to be difficult. Recent work has shown that the rate of binaries appears to be anti-correlated with the metallicity of the stars, at least in the solar neighborhood. However, extrapolating this relationship in order to model binary fractions in the early universe is less than ideal. For that, using relics of that time period would provide valuable context. Fortunately, the Milky Way (MW) is surrounded by a number of such relics in the dwarf spheroidal (dSph) and ultra-faint dwarf (UFD) galaxy population. However, the heterogeneity in the MW satellite sample, with a variety of different methodologies including spectroscopic and photometric used to measure the binary fraction, dramatically complicates drawing broader conclusions about the formation and subsequent impact of binaries. As such, we propose to systematically measure the binary fractions across all classical dSphs and UFD galaxies for which deep archival HST observations exist. This dataset will offer an unprecedented opportunity to examine the relationship across a wide range of galaxy properties (e.g., metallicty, host mass, star formation history) and the binary fraction of those systems, informing our models of star formation and galaxy evolution back to the early universe.

Proposal Category: AR
Scientific Category: Galaxies
ID: 17057
Program Title: Tackling the Mysteries of the Bizarre ISM in Blue And Dusty Gas Rich sources - 'BADGRs' - Using Extinction Mapping

Principal Investigator: Clark, Christopher

PI Institution: Space Telescope Science Institute

Over the past decade, high-resolution large-area FIR-submm surveys have revealed a previously-overlooked class of nearby galaxies with bizarre ISM properties: Blue And Dusty Gas-Rich sources - 'BADGRs'. BADGRs are very blue flocculent/irregular galaxies, typically containing a greater mass of HI than stars, and are the most dust-rich galaxies in the modern Universe, with M_d/M_s > 10^-2.75. But despite this dust richness, the fraction of their UV photons that is absorbed by dust is 5-20 times less than in normal late-type galaxies (traced by BADGRs' exceptionally low IRX ratios). Furthermore, BADGRs are very poor in molecular gas, despite having high specific star formation rates; and have unusually cold dust, despite intense UV radiation fields. Existing data are unable to explain the multiple paradoxes presented by BADGRs. High-resolution star-by-star extinction mapping is the tool we need to untangle their mysteries. There are two BADGRs, NGC4449 & NGC7793, that are close enough, and have the required archival HST data, to enable this. We will use these data to fit the multi- wavelength SEDs of the stars in these BADGRs, modelling the dust along the line-of-sight to each. With the resulting high-resolution extinction maps we will: compare the detailed dust geometry to the UV radiation field; relate dust temperatures to the energy balance between extinction & emission; determine if dust mass opacity in BADGRs is different from normal galaxies; test if the lack of molecular gas is due to CO freeze-out in opaque dust clouds; and quantify the molecular star forming efficiency in different regions, by comparing our maps of extinction & young stars to public ALMA CO data.

Proposal Category: AR
Scientific Category: Galaxies
ID: 17058
Program Title: Augmenting the SFR-M* Plane with Galaxy Star Formation History Trajectories

Principal Investigator: Iyer, Kartheik

PI Institution: University of Toronto

Incorporating information from the star formation histories (SFH) of individual galaxies into traditional 'snapshots' of scaling relations will provide transformative advances in our understanding of galaxy populations and star formation over cosmic time. Over the past years, improved methods to recover SFH information applied to high-quality multi-wavelength photometric surveys have allowed for significant gains in SFH reconstruction. We propose to augment the information in the SFR-M* plane with trajectories from the derived SFHs of galaxies at 0.5<z<3 in the deepest Hubble fields (CANDELS and the Hubble Frontier Fields). To robustly measure the SFHs, we combine the outputs from 4 state-of-the-art SED fitting codes and thus quantify the modeling uncertainties in the trajectories. As a proof of concept, we compare the trajectories of real galaxies in a single CANDELS field (GOODS-S) at z~1 with predictions of two models that are capable of producing distributions in SFR-M* space identical to the real observations, but make significantly different predictions for trajectories. Trajectories in SFR-M* space allow for better matching of individual galaxies to their progenitors across different redshifts and provide novel metrics against which to evaluate predictions from state of the art cosmological simulations. This technique can also be extended to other datasets and upcoming observations from JWST, allowing us to push this analysis to 3<z<9.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17059
Program Title: A complete, uniform, and astrometrically calibrated optical image library of all debris disk stars targeted with HST coronagraphy

Principal Investigator: Kalas, Paul

PI Institution: University of California - Berkeley

HST has delivered breakthrough high-contrast images of debris disks surrounding bright nearby stars that are universally recognized as pioneering for the field of exoplanets. These archival data could continue to have a critical scientific impact when advanced observatories such as ground-based AO, ALMA, and soon JWST, target the very same disks and will depend on HST's optical data to interpret the longer wavelength results. Despite the impactful role of HST debris disk imaging that began 28 years ago, only the NICMOS data have been processed for a legacy archive. Here we propose to reprocess all of the optical HST data on debris disks in a uniform manner that includes PSF subtractions and astrometric calibrations using Gaia. The Gaia astrometric calibration is a new and powerful method to solve a difficult problem: in the vast majority of debris disk studies to date, the position of the target star is not known to high precision because it is occulted by a coronagraph. This hampers the discovery and tracking of disk features or point sources moving in the time domain relative to the host star. In this legacy database, investigators will be able to download the PSF-subtracted data, including those fields with non-detections of disks, and immediately obtain reliable astrometry of sources relative to the host star. The library of disk images will enable the precision tracking of exoplanets and disk features, the exploration of population statistics, the multi-wavelength analysis of debris disk architectures and grain properties, and the testing of new theories, thereby ensuring that these HST data are meaningful for a new generation of exoplanet studies.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17060
Program Title: The Radiation Field of LI(N)ERs: The Milky Way as an Extragalactic System

Principal Investigator: Krishnarao, Dhanesh

PI Institution: Colorado College

Decades of UV absorption line studies of the Circumgalactic Medium (CGM) of the Milky Way and Magellanic Clouds have revealed crucial information on the physical conditions and distribution of gas surrounding galaxies. However, a precise analysis of these UV absorption line properties requires an accurate understanding of the emerging radiation field from the inner Milky Way, which photoionizes the gas. Currently, the radiation field shape widely used in the literature for these studies is built upon the stellar population surrounding the solar neighborhood. However, recent observations of optical emission lines from the inner Milky Way, towards the same direction as previous HST UV absorption line observations, have revealed clear evidence for significant differences between the local and inner Galaxy radiation fields. In particular, optical emission line ratio observations show that the inner Milky Way is largely ionized and similar to a class of extragalactic systems known as Low Ionization (Nuclear) Emission Regions--LI(N)ERs. We propose to use the inner Milky Way as a bridge to tie extragalactic and Galactic efforts in full Spectral Energy Distribution (SED) models and provide a realistic SED of the inner Milky Way. Our work will provide a more complete understanding of the source of ionization of LI(N)ERs seen in many galaxies, where only optical emission has been previously used as a constraint. In addition, our new SED will provide an accurate representation of the radiation field escaping from Galactic Center and photoionzing gas in the CGM of the Milky Way and Magellanic Couds and is crucial to fully understand the co-evolution of Local Group galaxies.

Proposal Category: AR
Scientific Category: Large Scale Structure of the Universe
ID: 17061
Program Title: Exploring the dark sector with correlation anisotropies

Principal Investigator: Cyr-Racine, Francis-Yan

PI Institution: University of New Mexico

Observations of galaxy-scale strong gravitational lenses have been used to put constraints on dark matter physics. It is now widely recognized that line-of-sight structures between the source and the observer play a significant role in perturbing lensed images, hence making multi-plane lensing a necessary part of any lens analysis. We propose here to utilize a freshly proposed approach that simplifies the multiplane nature of the lensing problem to an "effective" single mapping between the source and image planes to constrain dark matter. This mapping is fully characterized by two "effective" lensing potentials encompassing the complete structure of the deflection field. We propose to make detailed predictions for the statistical properties of these two potentials and their corresponding correlation function anisotropies in well-motivated dark matter theories. Since line-of-sight structure and main-lens substructure contribute differently to each potential, this method has the potential to distinguish these two contributions from one another, potentially improving the constraint on dark matter from strong lensing significantly. We also propose to further develop a likelihood framework to assess the sensitivity of mock data to anisotropic signatures, hence laying the groundwork for a future archival proposal to perform an in-depth study using past HST data. We will also perform forecasts for how future observations could separately constrain observables and what the resulting constraints on dark matter physics would be.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17062
Program Title: Revisiting SH0ES: A Search for Light Echoes Around Type Ia Supernovae

Principal Investigator: Wood, Charlotte

PI Institution: University of Notre Dame

Type Ia supernovae are important distance indicators for cosmology, however the neither the exact progenitor system nor the relative rates of different progenitor systems for these supernovae are well known. Important observational differences exist between the two main progenitor types - single-degenerate systems are expected to exhibit more dust than double-degenerate systems on account of the accretion disk. One way to illuminate the dust around type Ia supernovae is to search for light echoes: transient reflection nebulae created by dust scattering light into our line of sight. In order to obtain the most complete information from light echoes, they need to be resolved. Therefore, we are limited to the closest type Ia supernovae for our search. The most recent SH0ES analysis of 42 type Ia supernovae (Riess et al. 2021) provides a natural sample for a light echo search, as the archival data is in the correct filters and targets nearby star-forming supernova host galaxies with plenty of dust. We propose to analyze the SH0ES archival data and additional data from other proposals to identify new light echoes around type Ia supernovae and then use those light echoes to map the dust distributions, constrain the progenitors, and constrain the dust properties of the host galaxy.

Proposal Category: AR
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17063
Program Title: AR: Calibrating the Black-Hole Mass Scaling Relations using Reverberation-Mapped Active Galaxies with Velocity-Resolved Measurements

Principal Investigator: Bennert, Vardha

PI Institution: California Polytechnic State University San Luis Obispo

Reverberation mapping (RM) determines the mass of black holes (MBH) in active galactic nuclei (AGNs) by resolving the BH gravitational sphere of influence "in time". The resulting relationship between broad-line region (BLR) radius and AGN luminosity (the "R-L relation") is the foundation of virtually all MBH measurements beyond the local universe. Recent RM campaigns with high-quality data (cadence and S/N) yielded velocity-resolved time lags and independent BH masses for a sample of 29 objects, spanning a wide range of AGN luminosities and BH masses (6.4<log MBH/Msun<9.1). Integral-field spectroscopy was obtained with state-of-the-art instruments (Keck/KCWI and VLT/MUSE) for 11 objects for a robust measurement of stellar-velocity dispersion. HST images are essential to: (i) separate the nuclear luminosity from that of the host and thus calibrate the R-L relation over a wide mass range; (ii) determine the correlations between MBH and host-galaxy properties, such as bulge and host-galaxy luminosities, bulge effective-radii, and morphology (frequency of pseudo-bulges, bars, and mergers). Archival HST images are available for 18 objects (this AR proposal), we also proposed for the remaining 11 (GO proposal ID 3089). This sample has the most accurate MBH measurements beyond the local universe and will provide a fundamental local benchmark for studies of the evolution of massive black holes and their host galaxies across cosmic time. Measuring the distribution and scatter of f factors and looking for other dependencies to go beyond the sample-average f factor will help to better constrain the single-epoch BH mass.

Proposal Category: AR
Scientific Category: Stellar Physics and Stellar Types
ID: 17064
Program Title: Advancing our understanding of stellar variability with the Panchromatic Hubble Andromeda Treasury

Principal Investigator: Soraisam, Monika

PI Institution: NOIRLab - Gemini North (HI)

Although time-domain data from ground-based surveys are abundant, extragalactic variable stars in crowded regions (such as stellar clusters) and in the faint regime, i.e., the lower part of the Hertzsprung-Russell diagram, are beyond the reach of these surveys due to limitations on angular resolution and sensitivity. On these fronts, the Panchromatic Hubble Andromeda Treasury (PHAT) survey of our spiral neighbor M31, with a resolution of a few tens of milli-arcseconds and a depth reaching 27-28 mag, is unrivaled. It has yielded significant scientific products, among others resolved maps of star formation history (SFH), as well as catalogs of stellar clusters in its footprint. Interestingly, the PHAT survey has a time-domain facet on account of its tiling strategy, particularly in the optical filters F814W and F475W, resulting in sparse light curves for stars covering a wide range of baselines from hours to months. These light curves remain largely unexplored. We propose to perform the first systematic studies of (1) faint, i.e., F814W>20, variable stars, and (2) luminous variables in clusters in a Milky Way analog by mining the PHAT dataset. We will derive their variability characteristics (such as amplitude, color variation) and use available information of their local environment (e.g., age of the cluster, SFH map) to constrain their progenitors and confront with theoretical pulsation models. We will perform comparisons between our results and those from the metal-poor Magellanic Clouds, as well as between our cluster variable stars and field variable stars in M31, to constrain the effect of the environment.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17065
Program Title: Resolving a Massive Node of the Cosmic Web at z=3

Principal Investigator: Cantalupo, Sebastiano

PI Institution: Universita di Milano-Bicocca

How do galaxies get their gas? What is the morphology and kinematics of the accreting gas and how does this affect galaxy evolution? A recent MUSE observation targeting a quasar at z=3 has finally provided the way to directly address these questions through one of the first images of contiguous Cosmic Web filaments on scales of several comoving Mpc. The filaments converge into a node associated with a large concentration of galaxies: two of these - separated only by 2" - have AGN-like spectra making them one of the few known close-binary AGN at high-z and the only triplet, including the quasar, which is 10" away. Because of the seeing-limited nature of the MUSE observations, the majority of the galaxies associated to the filaments and the AGN hosts are unresolved. To overcome this limitation we propose ACS imaging in two filters sampling the galaxy rest-frame UV continuum emission in order to: i) reveal the relation between the gaseous filaments properties (such as gas densities and kinematics) and the morphological properties (such as size, clumpiness and structural parameters) of the associated galaxy star forming regions in order to study how galaxies form their stars, ii) detect the diffuse UV light associated with galaxy interactions and intergalactic star formation in order to constrain the role of environment in the formation of the stellar and AGN components of the progenitor of today's massive galaxies. The proposed ACS imaging will be the perfect complement to the multi-wavelength, ongoing deep observations with JWST, ALMA and Chandra on this field providing a new window on the study of early galaxy and structure formation in a massive node of the Cosmic Web.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17066
Program Title: Unprecedented Light Element Abundances: Planetary Crusts or Icy Moons?

Principal Investigator: Klein, Beth

PI Institution: University of California - Los Angeles

The recent first-ever detections of the light elements, lithium and beryllium, in planetary bodies accreted by 'polluted' white dwarf stars, has prompted varied explanations regarding their origin. A remarkable aspect of the observations is that the abundance ratios of Li and Be relative to major elements are significantly overabundant -- for Be the overabundance is two orders of magnitude. On the one hand, these elements are dosimeters for radiation environments and may be giving us a measure of the degree of spallation production that has occurred while the exoplanetary bodies were forming. On the other hand, chemical processes such as igneous differentiation (i.e. crust formation) could be responsible. The last member of the set of light elements, boron, has never yet been observed in white dwarfs. We propose to conduct observations of the most promising WD that would be expected to display boron, and we can use the relative abundances of B and Be to discern between the possible formation scenarios. Furthermore, the proposed observations are expected to easily measure the volatiles, C and N, in our target stars, and provide important constraints on the planetary formation scenarios being tested. Only HST/COS can provide the required UV spectroscopy to observe B, C, and N, which are critical for this science.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17067
Program Title: The diversity of protoplanetary disks: Imaging a complete sample of edge-on disks in four nearby star-forming regions

Principal Investigator: Duchene, Gaspard

PI Institution: University of California - Berkeley

The remarkable breadth of exoplanetary systems most likely finds its origin in their parent protoplanetary disks. Understanding the diversity of the physical properties and evolutionary pathways of these disks is therefore key to interpret the wealth of data that has been accumulated on exoplanets over the past two decades. High-angular resolution observations of disks, the most direct method to characterize their properties, is a challenging task in most cases and detailed individual studies are limited to a small set of favorable objects which are unlikely to be representative of the entire population. Edge-on protoplanetary disks offer unique advantages by blocking direct starlight and by providing an ideal perspective to study the disk vertical structure, which is expected to be affected by dust settling as part of the planet formation process. After a few serendipitous early discoveries, a method to identify likely edge-on disks was designed based on their peculiar spectral energy distribution. An HST pilot program confirmed that over half of the candidates were resolved as edge-on disks. Here we propose to conduct a complete survey of all HST-accessible edge-on disk candidates in four nearby star-forming regions (Taurus-Auriga, Chamaeleon, Lupus, Ophiuchus) to confirm their nature, and to enable a statistically meaningful ensemble analysis of the properties of protoplanetary disks. This survey is expected to roughly triple the number of edge-on disks identified through a uniform set of criteria in these regions and will allow us to empirically determine the true diversity of disk properties and to identify trends connected to disk evolution.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17068
Program Title: Young Stars and Gas Structure within the ALMA Coverage of Dwarf Irregular Galaxy WLM

Principal Investigator: Archer, Haylee

PI Institution: Arizona State University

We request HST WFC3/UVIS and WFC3/IR observations of the areas within local dwarf irregular galaxy WLM that have been surveyed with ALMA in CO(2-1) and CO(1-0) in order to dissect and understand the star forming regions in this low-metallicity environment. WLM has an oxygen abundance that is 13% of solar, and the structure of the molecular clouds at these low metallicities is fundamentally different from those found in higher metallicity spirals such as the Milky Way. Recent analysis of star forming regions with CO cores within WLM raised questions about the role of these cores in the overall star forming event in these regions. The proposed HST observations from 0.275 to 1.6 microns will allow (1) measurements of the age and extinction toward massive stars that have formed in the star-forming regions, (2) calculation of the ionized gas mass in the star-forming regions, (3) constraint of the cloud boundaries, (4) identification of YSOs that are forming in the CO cores and determination of their evolutionary stage, (5) mapping of the extinction as a tracer of the gas within the star-forming regions, and (6) placement of the CO cores in the context of the gas and dust. This is crucial for our understanding of the role of the small CO cores in low metallicity star-forming regions.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17069
Program Title: The Lyman-alpha and Continuum Origins Survey (LaCOS)

Principal Investigator: Hayes, Matthew

PI Institution: Stockholm University

The Low-Redshift Lyman Continuum Survey (LzLCS) is a HST Large program using the Cosmic Origins Spectrograph to provide direct measurements of the ionizing radiation (Lyman continuum; LyC) of 66 star-forming galaxies. The completed survey showed that ~50% of LzLCS galaxies are LyC emitters. Most of these objects are analogous to the high-z galaxies responsible for initiating and sustaining the epoch of reionization (EoR), and ~70% have Lyman-alpha EW>25 Angstrom. However the COS observations are spatially unresolved and capture only light emitted from a vignetted 2.5 arcsec region, centered upon the galaxies. Here we propose a 119-orbit program to obtain spatially resolved panchromatic imaging of 41 of these galaxies to closely examine the physical properties and geometry of their central and outer regions. We will obtain images in five filters (far-UV to visible) and produce maps of the stellar population and Lyman-alpha emission, and facilitate numerous investigations relevant for calibrating proxies of LyC output. The program will map the dust obscuration, star-formation rate and history, and ionizing stellar properties. These Ly-alpha images will provide essential information regarding the physical state of the ISM and its intimate role in regulating LyC transmission, by contrasting line and continuum images to test resonance scattering. The combined dataset will provide many unique measurements that are well-aligned with the UV initiative, have enormous archival utility, and will produce a dataset that can be applied directly to JWST studies of the EoR.

Proposal Category: SNAP
Scientific Category: Stellar Physics and Stellar Types
ID: 17070
Program Title: Snapshot Observations of Type II Supernovae

Principal Investigator: Kilpatrick, Charles

PI Institution: Northwestern University

Hydrogen-rich (Type II) supernovae exhibit enormous photometric and spectroscopic diversity that is still poorly understood despite being the largest sub-class of supernovae in volume-limited surveys and having a large sample of directly detected progenitor stars. Much of this diversity is driven by mass loss, which strips the progenitor star and pollutes its circumstellar environment with gas and dust. HST can make significant contributions to understanding both the properties of the progenitor system and nature of the circumstellar environment through targeted observations of a large, statistical sample of Type II supernovae. We will use multi-band imaging to resolve the stellar population around a large number of Type II supernovae, enabling isochrone fitting and thus an initial mass estimate, and producing the largest and most constraining sample to date of progenitor star initial mass estimates. We will also look for late-time emission from nearby supernovae, potentially revealing delayed circumstellar interaction and uncovering modes of mass loss from centuries before explosion. For the closest events, our observations will enable us to search for surviving companion stars to Type II supernovae, connecting the spectroscopic and photometric diversity we see to the configuration of their progenitor systems.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17071
Program Title: The Ionizing EUV Continua of Quasars: Minding the Gap

Principal Investigator: Shull, J.

PI Institution: University of Colorado at Boulder

Despite several decades of UV observations, the rest-frame ionizing spectrum of QSOs remains uncertain, primarily because of insufficient wavelength coverage to identify strong absorbers and measure spectral curvature between the EUV/FUV and NUV/Optical. The primary goal of this proposal is to define the continuum of QSOs, for ionizing (Lyman continuum) wavelengths through the NUV and optical. This requires "filling the NUV gap" for intermediate-redshift AGN (z = 1.5-2.2) with existing COS/G140L (FUV) and optical (SDSS) spectra. To fit the continuum over a broad wavelength interval, with access to windows of line-free continuum, we need spectra (2000-3500A) that connect FUV and optical wavelengths. This region contains important absorption-line diagnostics, including higher Lyman lines associated with LLS and pLLS absorbers. We request 26 orbits to obtain COS/G230L near-UV spectra of 12 AGN at redshifts z = 1.51-2.12 with existing far-UV (COS/G140L) and optical spectra (SDSS/6dF). This will extend the AGN composite spectrum down to 360-420A and investigate possible spectral hardening at wavelengths below 600A. We will also derive limits on EUV turn-overs and the He I continuum edge (504A) predicted in some models of accretion disks. Our spectra will also measure higher Lyman lines associated with strong (LLS/pLLS) absorbers and prominent QSO broad emission lines in the EUV that contaminate the underlying continuum.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17072
Program Title: From atomic physics to stellar evolution: decoding the heavy-metal subdwarfs with HST

Principal Investigator: Dorsch, Matti

PI Institution: Dr. Karl Remeis-Observatory, FAU Erlangen-Nurnberg

Hot subdwarf stars are helium-burning stars that are believed to form either via stripping of red giants' envelopes in binaries or by helium white dwarf mergers. They display a large variety of chemical peculiarities. Helium poor sdBs are found at Teff<35kK while extremely helium rich sdOs dominate at Teff>40kK. Particularly interesting are the rare mixed H/He composition iHe-sdOBs which bridge the gap. They may either be in a process of transition from red giant core to He-poor sdB, simply have insufficient hydrogen to quench the helium, or be the product of some other history. Several iHe-sdOBs show peculiar surface compositions with extraordinarily large enrichments of heavy elements (e.g. Zr, Pb by 4-6 dex). With two exceptions, these stars are completely unexplored in the space ultraviolet. We selected three "extreme chemistry" iHe-sdOBs that from a sequence of increasing Teff and helium abundance. This includes the recently discovered EC22536-5304, which resides in a binary with a very metal poor sdF-type companion, and likely formed via stripping by mass transfer to the sdF. UV spectra will allow us to determine 1) the abundances of a dozen or more species not observable in the optical, including the iron group, 2) the degree of stratification in the atmosphere (how thick is the enhanced layer?), 3) lead isotope ratios in the bright, lead-rich star HD127493. The results will allow us to explore the processes that may lead to heavily stratified envelopes and to study the transformation of red giant cores or white dwarf mergers with a helium-enriched surface into helium-poor sdBs. In addition, they will test alternative scenarios, such as pollution by SN ejecta.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17073
Program Title: AGN variability at cosmic dawn: a census of the youngest supermassive black holes

Principal Investigator: Hayes, Matthew

PI Institution: Stockholm University

The origin and growth of the first supermassive black holes (SMBH) has become one of the most pressing unsolved problems in astrophysics. SMBHs are present in the nuclei of most massive galaxies and impact many aspects of galaxy evolution, including feedback, morphological transformations, and cosmic reionization. Several scenarios can explain how the seeds of SMBHs may have been planted, but without accurate and direct observational estimates of their comoving number density, it is hard to distinguish between them. Under popular formation scenarios, SMBHs undergo their period of most rapid growth at high-redshift, beyond z=6. However, at this distance only the most luminous quasars have been identified, which reveal a very biased picture of the universe. AGN at intermediate luminosities (M_UV=-21 to -18, hereafter IL-AGN) must also be present, and are probably growing rapidly at z~6-10. These objects go undetected in current deep NIR imaging surveys, where they masquerade instead as star-forming galaxies. We argue here that the most reliable, yet unexplored, way to test all these highest-redshift systems for AGN activity is through variability. We therefore request 30 orbits to re-image the Hubble Ultra Deep Field with WFC3/IR/F140W, a decade after the first epoch was taken. This time delay, redshift, target restframe wavelength, and luminosity regime are all optimal for identifying AGN variability. We will make the first estimate of the comoving number density of SMBHs in the early universe, with target numbers sufficient to discriminate between black hole seeding scenarios.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17074
Program Title: Smoking guns in massive binary evolution: The hunt for Black Holes and Stripped Stars

Principal Investigator: Ramachandran, Varsha

PI Institution: Heidelberg University, Center for Astronomy

With the detection of gravitational waves from merging compact objects, a new observational window onto the fates of massive stars has been opened. To explain the observed mergers of compact objects, we need accurate knowledge about the evolution of massive binary stars. Yet, current population synthesis calculations often yield puzzling results, as they predict certain types of stellar systems in large numbers, which are rarely observed. Whether this is due to observational challenges or due to errors in the underlying evolutionary models, is one of the major open questions in massive star research. In this proposal, we tackle two crucial stages of massive binary evolution that are predicted in large numbers, but so far rarely observed: Systems containing an OB-star accompanied by an X-ray-quiet black hole (BH) and systems where a hot, envelope-stripped star is outshined by its OB-type companion. In both cases, the (compact) companion hardly leaves any trace in the optical beyond a suspicious, small He II disk-like emission. To identify the nature of the companion and distinguish between a BH and a stripped-star companion, UV spectroscopy is the only viable tool. With the unique capabilities of the HST, we will perform a pilot study for two prototypical systems in the Galaxy and the LMC that harbor either a BH or a stripped star companion. By determining the presence of tracing ions and the wind parameters of the stars, our study will confirm or deny the existence of the presently only known dormant BH in the Milky Way, marking an anchor point for our understanding of massive binary evolution and defining a framework for future observations of stripped stars.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17075
Program Title: Characterization of internal chemical spread in outer halo globular clusters

Principal Investigator: Lagioia, Edoardo

PI Institution: Universita degli Studi di Padova

Chemical spread of light elements and helium among stars, known as multiple stellar populations (MPs), is a common feature of old Galactic Globular Clusters (GCs). MPs are not observed among field stars, thus suggesting that their formation is bound to specific conditions of the pristine GC environment. However, the existence of GCs with no hint of the presence of MPs, dubbed simple population (SP) clusters represents a challenging conundrum for the theoretical models that seek to explain the origin of MPs. Despite their special characteristics, none of these GCs has been thoroughly analyzed in terms of internal chemical variations. The present project proposes the photometric characterization of a selection of four candidate SP GCs. We aim at understanding why MPs did not form in these systems and the role of environment of MP formation. This is a necessary step for an exhaustive comprehension of the origin of the MP phenomenon and the impact that GCs have had on the formation of the Galactic halo.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17076
Program Title: The C IV in L* galaxies (CIViL*) survey -- Pinpointing the physical conditions and evolutionary stages of gaseous halos

Principal Investigator: Berg, Trystyn

PI Institution: European Southern Observatory - Chile

The circumgalactic medium (CGM) plays a crucial role in galaxy evolution, hosting the gaseous reservoirs that feeds accreting material to replenish fuel for future star formation whilst retaining a record of material ejected by winds and feedback processes. Quantifying the connection between these gaseous reservoirs and their host galaxies provides essential constraints on the specific events that transform galaxies. The Cosmic Origins Spectrograph (COS) has played a significant role in studying the CGM over the past decade by providing an unbiased census of the gas around galaxies over a mass range that spans dwarfs to L* galaxies, as well as special evolutionary phases (such as active galactic nuclei [AGN] or starbursts). However, despite CIV being arguably the best tracer of galactic gas reservoirs across cosmic time, these galaxy-selected COS surveys lack spectral coverage of CIV surrounding a necessary benchmark sample of L* galaxies. Our proposed survey aims to quantify the amount of CIV in the CGM of 13 L* galaxies, and for the first time: (i) constrain feedback processes from AGN and starbursts within 200 kpc, (ii) quantify the radial CIV profile to guide modeled stellar wind and black hole feedback perscriptions across three decades of stellar mass, and (iii) derive the physical conditions within the CGM by studying its ionization structure. Our carefully crafted representative L* galaxy sample will add to the legacy of COS-CGM studies by including a key ion for diagnosing the physical properties of the CGM.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17077
Program Title: The 25,000-Lightcurve HST-Kepler Treasury Survey

Principal Investigator: Bedin, Luigi

PI Institution: Osservatorio Astronomico di Padova

In the Kepler database lies an important and yet unexplored opportunity. The two "super-apertures" centered on the star clusters: NGC 6791 and NGC 6819 - each containing several thousands stars - have been monitored almost continuously for over 4 yrs. If their stellar populations could be disentangled, then these Kepler datasets would be of groundbreaking importance to assess planet occurrence rates in two uniquely large groups of homogeneous and coeval stars. We propose to obtain high-resolution HST images within these two super-aperture fields and use a well tested method (already proved successful) to combine Kepler lightcurves with HST source information. The unmatched HST image quality will provide a homogeneous, complete, and color-complete input list which will enable extracting Kepler light curves of all the objects. Furthermore, HST allows us to obtain proper motions linked to the Gaia system and membership for all these stars. The combined data will provide about 25,000 lightcurves - increasing the total Kepler sample by 15%! Based on the latest planet occurrence rates we expect to find over 70 transiting planets -- ~40 in the solar-metallicity NGC 6819, and about 30-50 in the super-solar metallicity NGC 6791. Our program will greatly enhance the Kepler mission's yield, boost the number of known transiting planets, and will allow a direct test of the planet occurrence rate-metallicity relationship in uniquely homogeneous and well-characterized samples. The proposed data will also enable many other investigations, enhancing the legacy and the scientific impact of both the HST and the Kepler missions, and target selections for future JWST and ARIEL follow-ups.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17078
Program Title: A multi-wavelength view of interstellar dust

Principal Investigator: Zeegers, Sascha

PI Institution: Academia Sinica, Institute of Astronomy and Astrophysics

Dust in the diffuse interstellar medium is a major contributor to the energy balance and chemistry in galaxies. Its properties are typically characterized in extinction against background sources, and have yielded a well-described interstellar extinction curve (IEC), that can be explained by several dust models. We propose to observe with HST/STIS 12 sightlines towards O and B stars selected in approved JWST program 2183, yielding a continuous spectrum over 0.11-28 micron with relatively uniform S/N. HST/STIS is currently the only instrument available that can provide spectroscopy to be effectively combined with JWST when targeting O and B stars. Analysis of the combined data set will result in a refining of the interstellar dust models, and further explore variations between sightlines. Several dust features in the IEC accessible with HST/STIS, most notably the 2175 A bump, but also the newly described intermediate scale structure features in the optical (Massa et al. 2020), will be compared to dust features in the infrared spectrum in order to further constrain the nature of their carriers. The overall shape of the IEC over the UV/optical/infrared wavelength range will further constrain the composition of the interstellar dust, in particular the balance between silicate and carbonaceous dust components, as well as the grain size distribution in the ISM.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 17079
Program Title: TRGB and Cepheid distance scales: is there local tension?

Principal Investigator: Jang, In Sung

PI Institution: University of Chicago

The Tip of the Red Giant Branch (TRGB) and the Leavitt Law for Cepheids are two of the most precise means of measuring the local distance scale. Recent studies have shown that the TRGB distance scale gives H0 = 69.8 +/- 1.7 km/s/Mpc, and it is sitting midway of two earlier measurements based on the Cepheid distance scale (H0 = 73.0 +/- 1.0 km/s/Mpc) and the cosmological modeling of the Planck data (H0 = 67.4 +/- 0.5 km/s/Mpc). This new 'local tension' between the TRGB and Cepheid distance scales is a growing issue we need to understand and resolve before claiming new physics beyond the current scope of the LambdaCDM standard model. A direct, galaxy-by-galaxy distance comparison is urgently needed to address the possible systematics of the two local distance scales. However, such a test does not provide a clear answer for now because only a small number of galaxies - less than 25% of the total calibrator galaxies - is available for the direct comparison. We propose to use HST to increase the number of the overlapping calibrator galaxies by nearly a factor of two. We will compare their TRGB and Cepheid distances to see if they agree well (the local distance scale is robust) or not (new systematics are indicated). This increased sample of calibrator galaxies will provide us with a volume-limited sample (d < 20 Mpc) and immediately result in the derivation of a value of H0 accurate to 1.8% based on the TRGB distance scale alone. Our volume limited and optically well calibrated sample of TRGB hosts will form important testing grounds for the future calibrations and expanded applications with JWST.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17080
Program Title: Astrometric search for Planets orbiting the closest Y Dwarf

Principal Investigator: Bedin, Luigi

PI Institution: Osservatorio Astronomico di Padova

Located at 2.2 pc, the ~250K Y2 (sub-)brown dwarf WISE J085510.83-071442.5 is the fourth closest known system to Earth. Studying this object provides unique insights into brown dwarf (and exoplanet) atmospheric properties, thermal evolution, multiplicity, and planet-hosting prospects. We propose to use HST to obtain one the most accurate annual parallax of this - or any - planetary-mass brown dwarf to date, achieving an unprecedented accuracy of 200 micro-arcseconds, and constraining its absolute space motion to equivalent accuracy. More importantly, we will be able to search for faint companions co-moving with the target, either resolved or through astrometric perturbations of its linear motion, the latter probing down to a few Earth masses. HST is the optimal facility for precision astrometric measurement of WISE 0855-0714, as this source is too cool and faint at optical and near-infrared wavelengths to observe with ground-based facilities or Gaia. Our observations will improve current astrometric precision of this source by a factor of 40 and anchor future JWST measurements of this and other cold brown dwarfs, while providing high-precision distance and motion measurements and tight constraints on planetary-mass companions for one of the closest ``stellar object'' to the Sun.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17081
Program Title: Mass Measurement of a Candidate Balck Hole Microlens with Systematic Error Control

Principal Investigator: Bennett, David

PI Institution: University of Maryland

We propose Hubble imaging of the black hole candidate microlens system MOA-2019-BLG-284 in order to measure the astrometric microlensing signal and determine the lens system mass. Microlensing is the only method that can detect black holes that are isolated or in stable, non-accreting binary systems, so routine detection of black hole astrometric microlensing will provide a significant advance in our understanding of the formation of stellar mass black holes. Our proposed observations will determine if the MOA-2019-BLG-284 lens system is a rare stable binary system with a black hole primary or an isolated stellar mass black hole. This observing program is designed address possible systematic errors in the astrometric measurements. We will also use the Hubble data to correct systematic errors in the ground-based photometry that determines the microlensing parallax. Since both astrometric microlensing and microlensing parallx measurements are needed to determine black hole masses, an understanding of systematic errors in both quantaties is needed for reliable mass measurements. The novel systematic error correction methods that we propose may be used to increase the sensitivity of future black hole mass measurements from astrometric and photometric microlensing.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17082
Program Title: Measuring the refractory and volatile content of a dynamically distinct ultrahot Jupiter

Principal Investigator: Chachan, Yayaati

PI Institution: California Institute of Technology

Ultrahot Jupiters (UHJs) provide us with an exciting opportunity to probe the refractory content of exoplanetary atmospheres. These planets are hot enough to retain species such as iron and silicon in gaseous phase, which contribute significant opacity in the optical and near-IR but especially in near-UV. By observing a planet's transmission spectrum across this wide wavelength range with HST, we can measure the refractory abundance in its atmosphere. Additionally, we can characterize the refractory-to-volatile ratio of the planet by simultaneously measuring the water abundance in the near-IR. The joint characterization of refractory and volatile abundances can place significantly tighter constraints on the origin of gas giant planets than volatiles alone can. This technique has been used to characterize two UHJs (WASP-121b and WASP-178b) so far but both of them have polar orbits around their host stars. Here, we propose to observe the UHJ KELT-20b (Teq = 2260 K) that orbits a very bright and hot star (V mag = 7.6, Teff = 8720 K) and yet has a projected obliquity of 0.6 +/- 4 degrees. This extremely rare dynamical configuration for KELT-20b points to a formation and migration history that is potentially different from its compatriots. We will obtain a comprehensive transmission spectrum of KELT-20b and characterize both its refractory and water content by observing it with the WFC3 instrument in the UVIS, G102, and G141 bandpasses. With our proposed observations, we can strongly distinguish between different formation scenarios, evaluate the role of rainout, and determine if KELT-20b's distinct dynamical configuration is reflected in its atmospheric composition.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17083
Program Title: In search of the remnant of SN 2021fcg : detonation, deflagration or merger?

Principal Investigator: Karambelkar, Viraj

PI Institution: California Institute of Technology

Type Ia supernovae are thermonuclear explosions that result in the detonation of a white dwarf. Type Iax supernovae are a peculiar, less energetic sub-class of SNe Ia in which the white dwarf is believed to survive the explosion. This leaves behind a bound remnant, that is detectable at late-times when the supernova emission has faded. SN 2021fcg is a recently discovered unique member of this class. It is the lowest luminosity type Iax supernova as well as the least luminous thermonuclear explosion of any kind discovered to date. SN 2021fcg challenges the picture that SNe Iax originate in white dwarf deflagrations, and may hint towards a white dwarf merger origin. SN 2021fcg is also the nearest SN Iax discovered in the last decade, and provides an excellent opportunity to directly test the hypothesis that SNe Iax leave behind a bound remnant. Theoretical models predict that emission from the remnant will peak during HST Cycle 30. The supernova luminosity is also expected to be significantly lower than the predicted remnant luminosity during Cycle 30, making it feasible to detect the bound remnant in this cycle. We propose to conduct late-time multi-band optical and near-infrared imaging of SN 2021fcg using HST WFC3 to search for the bound remnant and determine the remnant properties.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17084
Program Title: Zooming In On Two Strongly Lensed Galaxies During the Epoch of Re-Ionization

Principal Investigator: Bayliss, Matthew

PI Institution: University of Cincinnati Main Campus

Deep field observations with the Hubble Space Telescope have revealed several hundred galaxy candidates in the universe's first billion years leading up to re-ionization, but only a small fraction are bright enough (H<24 AB) for detailed, high-S/N spectroscopic follow-up study with the James Webb Space Telescope (JWST). We propose for WFC3/IR + ACS imaging observations of two exceptionally bright (F110W_AB~23.8) z~7 dropout galaxies that were recently identified in archival HST data. Both targets appear as multiply imaged pairs near the cores of massive foreground galaxy clusters, indicating that they are strongly lensed, and therefore highly magnified. While both lensed sources appear as exceptionally bright z~7 galaxies, their intrinsic brightnesses are much smaller. Unlike the brightest high-z galaxies discovered in deep fields, our target source are drawn from the population of faint high-z galaxies that are likely responsible for re-ionization. These lensed sources provide a unique opportunity to performe detailed studies of typical, intrinsically faint, galaxies during the epoch of re-ionization. Our proposed observations will simultaneously achieve three science goals: 1) inform a detailed strong lensing model for each system (necessary to recover their true intrinsic properties), 2) measure the stellar mass and UV spectral slopes of multiple spatially resolved (via lensing magnification) star-forming clumps in each dropout galaxy, and 3) reduce photometric redshift uncertainties for both lensed galaxies by a factor >3x (necessary to plan future spectroscopic observations).

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17085
Program Title: Very Massive Stars in M33

Principal Investigator: Martins, Fabrice

PI Institution: Universite de Montpellier

Very massive stars (VMS) are stars with masses in excess of 100 Msun. They are formed in clusters massive enough to populate the initial mass function up to high masses. They are very luminous objects spectroscopically similar to, but much less evolved than, Wolf-Rayet stars. They dominate the integrated ultraviolet spectrum of young clusters. Incorporating them in population synthesis is crucial to interpret spectroscopy of unresolved star forming regions and galaxies such as observed by the CLASSY survey. However very few VMS are directly observable in the Local Universe, especially in the UV: there are about ten such objects located either in 30 Dor in the LMC or in the Galactic cluster NGC 3603. We propose to nearly double the number of VMS UV spectra by targeting the only other place in the Local Universe where VMS can be studied individually in the UV: the two giant HII regions NGC595 and NGC604 in the Triangulum galaxy M33. Our goal is to obtain STIS/G140L spectra of nine (candidate) VMS previously identified in M33. We will determine the stellar and wind properties of VMS at sub-LMC metallicity using atmosphere models. We will determine how their mass loss rate depend on luminosity and Eddington parameter and implement these mass loss rates into new evolutionary models of VMS. Finally, we will develop population synthesis models using new empirical and synthetic spectra of VMS.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17086
Program Title: Blowin' in the Wind - Proper Motion Kinematics of Massive Protostellar Outflows

Principal Investigator: Fedriani, Ruben

PI Institution: Chalmers University of Technology

The answer to the question of how massive stars form may be blowing in the winds that they launch during their main accretion phase. Such winds are expected to have terminal velocities similar to the escape speed of their launching region from the inner disk near the protostellar surface, which can be greater than 1000 km/s. Here we propose to re-observe three massive protostars that were imaged by HST WFC3/IR in 2016 to measure the expected proper motion of outflow knots, especially as traced by [FeII]. The measurements of the proper motions of these outflow features will be combined with ancillary NIR spectroscopic data to yield the most complete kinematic characterization of the fastest components of massive protostellar outflows. Such data will provide unique and powerful constraints on massive star formation models. This project will also enable proper motion studies of the YSO populations around the massive protostars, i.e., to measure the motion of the protocluster population compared to background field stars and to search for runaway stars. The flux variability of the jet knots, scattered light from the massive protostar, and from low-mass YSOs will also be studied, delivering additional important diagnostics of the outflow and accretion processes.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17087
Program Title: The final word: Documenting the Final Days of the Nearby Type Ia Supernova 2011fe

Principal Investigator: Shappee, Benjamin

PI Institution: University of Hawaii

Even though SNe Ia are crucial to cosmological studies as distance indicators, the exact nature of these systems remains theoretically ambiguous and observationally elusive. However, there is a new hope. The very late-time light curves of SNe Ia harbor important clues to the natures of their progenitor systems. First, the ejecta from the SN will shock heat a non-degenerate companion, leaving it luminous and visible at very late times after the SN has faded. Second, due to nucleosynthetic effects during the explosion, different explosion models are predicted to produce vastly differing amounts of 57Co and 55Fe. 57Co and 55Fe dominate the power of the very late time light curves of SNe Ia after >1050 days after the initial explosion. As the brightest SN Ia in 50 years, SN 2011fe offers a prime opportunity to follow a SN Ia to such late epochs. Multiple groups have used late-time HST observations to measure the bolometric luminosity, determine the ratio of these isotopes, and thus discriminate between progenitor models. However, the current measurements are degenerate between a 55Fe-powered light curve and the presence of a shock-heated companion at ~2400 days. Thus adding a significant caveat to any conclusions that can be drawn. Here we propose to break that degeneracy with a single ~4200-day F555W observation, nearly 4 times later than any other SN Ia has been observed. SN 2011fe is likely to remain the best-studied normal SN Ia of our generation and if these observations are not made while Hubble is operational, we will lose this opportunity.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17088
Program Title: High-redshift AGB analogs in the galaxy DDO 68

Principal Investigator: Goldman, Steven

PI Institution: Universities Space Research Association

The origin of the dust seen in high-redshift quasars remains controversial. Observations have shown that Asymptotic Giant Branch (AGB) stars can produce significant dust in the Magellanic Clouds and the Milky Way, but it is unclear whether dust production is as prolific in the metal-poor systems that are representative of high-redshift galaxies. In metal-poor environments, models suggest that dust production should be limited by a star's initial metallicity, since metals are necessary to seed the nucleation of dust grains. Observations of AGB stars in nearby metal-poor galaxies, however, suggest that dust production may not be inhibited at low metallicity environments. DDO 68 is the best nearby analog of high-redshift galaxies, whose stellar population can be resolved using HST. Given its metal-poor environment and high star formation rate, DDO 68 provides a unique opportunity to search for dust-producing AGB stars. Successful detection of dusty AGB stars will have major implications on dust evolution models by increasing the allowable dust formation at early epochs. We will observe DDO 68 in three medium-band WFC3/IR filters of HST to (1) unambiguously identify the AGB stars, (2) determine their chemical types, and (3) establish whether they are producing significant dust. With future follow-up spectroscopic observations using JWST, our proposed HST imaging campaign will enable detailed studies of the dust properties, composition, and masses. Thus, our proposed program is crucial to solving the decades long mystery, the "Dust Budget Crisis".

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17089
Program Title: Characterizing Primitive Asteroids

Principal Investigator: Hendrix, Amanda

PI Institution: Planetary Science Institute

Primitive classes of asteroids, namely those of the B, P, D and C-complex types, are not well characterized in terms of surface composition due to a lack of diagnostic spectral features at visible-near infrared (VNIR) wavelengths. This presents a critical problem because these are important objects due to their primitive nature and their links to early solar system processes. Indeed, the upcoming Lucy mission will visit C-type asteroid Donaldjohanson and several Trojan asteroids (P and D type asteroids). However, despite a lack of spectral features at VNIR wavelengths, these objects do exhibit varying strengths of UV absorption, as observed by the International Ultraviolet Explorer (IUE), which may be related to volatile abundance and thermal history. We propose to observe 6 low-albedo class main belt asteroids to characterize them in terms of their UV spectral shape. We will test the hypothesis that a spectral trend with heliocentric distance should be present, based on the changing thermal and compositional environment.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17090
Program Title: ANCHORING THE ENERGY BUDGET OF THE KEYSTONE JWST ERS ULTRA-HOT TARGET WASP-18 B

Principal Investigator: Piaulet, Caroline

PI Institution: Universite de Montreal

The exoplanet community has identified the massive ultra-hot Jupiter WASP-18b as one of the two keystone planets that will be observed as part of the JWST Transiting Exoplanets Early Release Science (ERS) program. These ERS observations will both serve the purpose of demonstrating JWST's capabilities as well as providing unprecedented infrared spectra for atmospheric characterization. A full MIRI phase curve of WASP-18 b as well as a NIRISS/SOSS eclipse in the ERS observations will deliver unprecedented constraints on the infrared emission spectrum of an exoplanet. However, the interpretation of the inferred dayside temperature profile, the overall energy budget, and the chemistry of WASP-18 b will be substantially hindered by our lack of constraints on the planetary albedo as well as the thermal emission shortward of 0.8 um. Here, we propose to observe two eclipses of WASP-18 b with the WFC3 UVIS G280 grism to spectroscopically measure the outgoing flux from 0.2 to 0.8 um. These observations will simultaneously capture the reflected light at short wavelengths and the considerable thermal emission between 0.5 and 0.8 um of WASP-18 b. Combined with JWST, our observations will provide the most complete spectral energy distribution of any exoplanet to date, with additional constraints on the scattering properties of the atmosphere as well as the presence or absence of short-wavelength absorbers such as TiO and VO believed to be responsible for thermal inversions in hot Jupiters. Overall, the UV-Visible HST observations combined with the JWST ERS infrared observations will enable an unprecedented holistic view into the energy budget and atmosphere processes of an exoplanet.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17091
Program Title: Compact oddballs in COSMOS: The Faint End of the z>6 Quasar Luminosity Function and the Growth of Ionized Bubbles

Principal Investigator: Faisst, Andreas

PI Institution: California Institute of Technology

Finding galaxies with an active galactic nucleus (AGN), or quasars, in the early Universe is the forefront of today's astronomical research. While luminous quasars have been well characterized, the number density of low-luminosity (<1E45 erg/s) quasars at z>6 is still uncertain. Constraining their numbers will tremendously advance our understanding of the processes which lead to the reionization of our Universe as well as the formation of the first supermassive black holes. Through stringent selection criteria including color and size, we have identified a complete sample of 7 low-luminosity quasar candidates in the 1.64 deg2 COSMOS field. Here we propose to use ACS/G800L slitless spectroscopy to confirm their redshifts via Ly-alpha and to study the spatial morphology of the emission. We will use the power of the grism to simultaneously measure Ly-alpha emission from color-selected star-forming galaxies within the ionized bubble of the quasar. This will allow us to (i) place the first constraints on the faint end of the quasar luminosity function at z>6, (ii) quantify the importance of low-luminosity quasars in the reionization process and place constraints on models of early supermassive black hole formation, (iii) study the relationship between Ly-alpha sizes and UV luminosities of low-luminosity quasars, a tracer of the size of the ionized bubbles and the clumping factor of the gas and (iv) measure star-formation in smaller halos in the local neighborhood of the quasars and statistically the Ly-alpha emitter density in the bubbles, compared to the field to further constrain the interplay between low-mass and high-mass halos in the growth of large scale structure.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17092
Program Title: Calibrating STIS Coronagraphic Spectroscopy for High Contrast Observations

Principal Investigator: Ward-Duong, Kimberly

PI Institution: Smith College

The Space Telescope Imaging Spectrograph (STIS) is currently the world's only available visible-light coronagraphic spectroscopy facility. The unique capabilities of R~500 optical spectroscopy at close angular separation (0.05-0.3") from a bright central object has been relatively unexplored with this mode and to-date are not yet fully calibrated. The goal of this program is to assess the achievable contrast, inner working angle, and fidelity of extracted spectra using the occulting fiducial F1 bar in the STIS 52x0.2 spectroscopic aperture. Targets will be two well-measured single A0V standard stars, in addition to a binary white dwarf companion system and PSF reference, wherein the faint companion has published images and low-resolution spectra against which STIS observations will be compared. Use of target offsets from the nominal bar acquisition positions, pushing the star as close as possible to the edge of the occulter, will allow us to determine the limits of coronagraphic performance achievable with this mode. The driving science benefit to the community is to provide well-calibrated contrast curves, an understanding of the noise properties and quality of extracted spectra in this mode. These measurements would have immediate utility for programs involving spectroscopy of imaged exoplanets, brown dwarfs, and close binary companions; circumstellar disks; jet-launching regions in young protostars; and AGN jets and host environments (i.e., any scientific case where optical spectra at very small angular separations are of interest). The proposed program will explore and calibrate the full capabilities of this unique mode made possible only with HST/STIS.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17093
Program Title: A Systematic Search for Wind-CGM Interactions in Star-forming Galaxies

Principal Investigator: Borthakur, Sanchayeeta

PI Institution: Arizona State University

In the current cosmological framework, galactic superwinds play a pivotal role in regulating star formation and producing the observed stellar mass function. Theory suggests that galactic winds impede the flow of cool gas from the circumgalactic medium (CGM) onto the disk of galaxies; however, the microphysics of how galactic winds do so is still a mystery. The goal of this program is to unveil this elusive process. We propose to observe the CGM of a complete sample of 42 galaxies via QSO-absorption spectroscopy in three coronal lines - CIV, NV, and OVI - that match the predicted energetics of the wind-CGM interactions. Theoretical models advocate that the differences in the strengths and kinematics of the coronal lines are necessary and sufficient indicators to identify the complex processes involved in the multiphase wind-CGM fluid interactions. Currently, we have only 4 galaxies with archival data on all three lines. Thus, the proposed dataset will be essential for constraining models of galactic feedback. Our program will - (1) detect evidence for wind-CGM interactions in star-forming galaxies; (2) determine how the strength of the wind-CGM interactions vary with galaxy properties; and (3) compare coronal lines between observations and those predicted by idealized and cosmological simulations. Our idealized simulations incorporate non-equilibrium physics in the presence of a weak magnetic field - conditions similar to the real CGM. We will release our data products to the community via the Hubble Legacy Archive within six months of the last observations. It will be a comprehensive dataset suitable for direct comparison with a host of ongoing simulation efforts.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17094
Program Title: Constraining the mass loss in evaporating planets by catching the second tail

Principal Investigator: Spake, Jessica

PI Institution: California Institute of Technology

Highly irradiated gas-giant exoplanets vigorously lose their atmospheres. This makes them excellent laboratories for extreme atmospheric physics - where we can study the effect of high levels of irradiation and stellar wind. Despite decades of observations with HST, the scientific value of the Lyman-alpha detections remains surprisingly under-exploited. In particular, the observations have not yet been able to precisely quantify planetary mass-loss rates. To address the gap between Lyman-alpha models and observations, a new observational pathway has been proposed to untangle the web of parameter interdependency. Originally identified in the 3D radiative-hydrodynamic simulations, this method requires measuring the second Lyman-alpha transits that are predicted to occur for hot Jupiters after the main transit. Second Lyman-alpha transits have never yet been probed or observed, despite this theoretical prediction. By measuring the time-delay of the secondary transit, the strength of the acceleration mechanism and the inertia of the outflowing gas can be measured, which is set by the mass loss rate. Thus, a measurement of a hot Jupiter's secondary transit will allow us to break the degeneracies that have plagued interpretation of Lyman-alpha transits, bringing firm physical constraints which will finally allow us to observationally, qualitatively constrain the mass-loss rate of an exoplanet.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17095
Program Title: The Missing Link in Massive Binary Star Evolution

Principal Investigator: Wang, Luqian

PI Institution: Yunnan Astronomical Observatory, CAS

Binaries are common among massive stars, and close pairs interact over their lifetime to transform the binary systems through the exchange of mass and angular momentum. The gainer star is spun up to near critical rotational velocity and the donor star is stripped of its outer envelope to reveal a hot and faint helium star. The detection of these faint helium stars is feasible using ultraviolet spectroscopy. Determining the orbital and physical properties of the helium stars is important to trace the evolutionary state of post-mass transfer binaries. Massive helium stars are the probable progenitors of neutron stars and black holes in X-ray binaries. Recent HST observations led to the detection of ten sdO stars in Be binaries and to estimates of their radii and effective temperatures. Five of the southern sky targets were not known binaries before the HST program, and a three-year program of optical spectroscopy reveals that they have very long periods that are only partially sampled in the existing HST data. Here we propose to revisit these five targets and obtain HST/STIS FUV spectroscopy to cover the full range of orbital Doppler shifts. This information will lead to the determination of the orbital and physical properties of the stars. The individual spectral components will be reconstructed using Doppler tomography to investigate the abundances and element diffusion processes in the helium stars.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17096
Program Title: Linking the UV Bump with PAHs in Low Metallicity Starburst II Zw 40

Principal Investigator: Lai, Thomas

PI Institution: Caltech/IPAC

We proposed to explore the connection between the 2175 angstrom UV bump and the Polycyclic Aromatic Hydrocarbons (PAHs) together with the cluster properties in a prototypical blue compact dwarf II Zw 40 using the FUV-NUV-optical filters F140LP, F225W, and F438W. The debate on what the carriers of the UV bump are is still unsettled, but PAH is one of the most plausible candidates. II Zw 40 has one of the highest star formation rate densities in the local Universe and has been found to exhibit strong 3.3 micron emission powered by the smallest PAHs. Our observation will take the advantage of the scheduled JWST GO1 program and use it as a supplement to showcase the combined power of the HST UV imaging and JWST IFUs to achieve our goal. Blue compact dwarf allows us to study starburst phenomena in the early Universe since they serve as powerful low-z, spatially resolvable analogs to high-z galaxies. Using HST multi-band imaging, we will constrain the strength of the UV bump and compare it with the spatially resolved dust properties in the IR revealed by JWST's IFUs. With our observation, we will also make possible a complete inventory of star clusters in II Zw 40 to further study cluster formation and evolution in this galaxy. There are existing archival HST UV data but they are not deep enough to meet our scientific objective. Our proposed program will obtain a much deeper UV mapping of II Zw 40 so that the amplitude of the UV bump can be better constrained. In total, we request 5 orbits of the HST observing time.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 17097
Program Title: Reinforcing the Distance Ladder with Cepheids in the Core of the SMC

Principal Investigator: Riess, Adam

PI Institution: The Johns Hopkins University

The Hubble tension between the value of the Hubble constant deteremined from the early and late Universe is the most remarkable development to strike cosmology since the discovery of Dark Energy, suggesting that LambdaCDM is still incomplete and raising the possible discovery of new cosmological physics. The leading evidence comes from an investment of >1000 HST orbits used to knit together geometric distances and Type Ia supernovae with nearby and extragalactic Cepheids to measure H0 to ~1 km/sec/Mpc uncertainty and reveal a 5 sigma tension with the prediction of H0 from the CMB. A rare opportunity to improve the foundation of the HST-built ladder comes from new measurements (in 2020) of the geometric distance to the SMC from 15 late-type detached eclipsing binaries that measure the distance to the core of the SMC to 1.5% precision. We propose to leverage and enhance this important finding by using the "DASH" observing mode with HST to efficiently measure >100 long-period Cepheids in 3 colors in the core of the SMC. These data can be tied directly, without any systematic zeropoint error to the existing Cepheid distance ladder, homogeneously constructed from HST data, to provide a new calibration of H0. This measurement will further increase the stability of this leading local distance ladder by increasing the number of its geometric anchor points from 3 to 4, allowing greater reliability by the ability to remove any and retain the result. The data will also extend the metallicity- luminosity relation of Cepheids to the lower abundances typical of the outskirts of spirals and offer the leading characterization of this surprising cosmological feature.

Proposal Category: SNAP
Scientific Category: Stellar Physics and Stellar Types
ID: 17098
Program Title: HST and Gaia, with Light and Distances, a Foundational Legacy of the Distance Ladder

Principal Investigator: Riess, Adam

PI Institution: The Johns Hopkins University

The leading determination of the Hubble constant comes from observations of Cepheid variables by HST calibrated by parallaxes from Gaia. This measurement is in tension with the value predicted by LambdaCDM calibrated by the CMB. The suggested limitation of the current cosmological model is a clue we must be pursue. The sample of Milky Way Cepheids observed by HST offers the means to build a still superior distance ladder and reach the long-targeted legacy goal of a 1% measurement of H0. Unfortunately, an unexpected Gaia anomaly has reduced the available precision of a Cepheid calibration sample planned well before Gaia's launch. We thus propose an HST SNAP program to double the current sample by imaging all remaining Milky Way Cepheids in Gaia's ``sweet spot'' for the greatest gain, using the same WFC3 bands for their extragalactic counterparts to nullify the effects of calibration errors along the distance ladder. The MW variables were selected to have the highest signal-to-noise in the measured parallaxes, the lowest reddening, to be fainter than Gaia's saturation limit, and with periods that directly calibrate extragalactic Cepheids and H0. The proposed sample has also been cleansed of astrometric binaries which degrade parallax precision, newly revealed by Gaia's EDR3 (December 2020). Together, Gaia and HST, each doing what they do best, can achieve what neither can do alone. Collecting these observations will lay a cornerstone for a 1% determination of H0 and continue to steadily advance our knowledge of what appears to be a new feature in the cosmological model.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17099
Program Title: Ganymede's water atmosphere in eclipse

Principal Investigator: Roth, Lorenz

PI Institution: Royal Institute of Technology

A recent analysis of HST/STIS images has revealed the presence of water vapor in the atmosphere of Ganymede, the largest moon of Jupiter and in the entire solar system. The derivation of H2O was through emissions from oxygen, using the relative brightness of far-UV multiplets at 1304 A and at 1356 A. The findings constitute the first detection of sublimated H2O in the outer solar system. This atmosphere likely collapses when Ganymede is eclipsed by Jupiter since surface temperature and sublimation flux are expected to decrease considerably. Here we propose follow-up observations to confirm the detection of H2O in the atmosphere and characterize the response of the H2O component to eclipse. For this, we use the succesful STIS FUV spectral imaging mode to monitor and map the diagnostic 1304 A and at 1356 A emissions from before to after a ~3-hour eclipse passage of Ganymede. During another eclipse occasion, we use COS and the G230L mode to measure OH aurora from dissociative excitation of H2O for the first time. This visit provides an independent confirmation of the H2O atmosphere. Ganymede is a primary target of ESA's JUpiter Icy Moon Explorer (JUICE) and NASA's Europa Clipper mission. An improved understanding of the moon's neutral environment delivers important information for optimal science planning and addressing the habitability goals for these milestone missions.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17100
Program Title: UV spectra of the most metal-deficient galaxies

Principal Investigator: Izotov, Yuri

PI Institution: Ukrainian National Academy of Sciences, BITP

Extremely metal-deficient (XMD), compact and low-mass star-forming galaxies (SFGs) at low redshifts are considered to be the likely nearby counterparts of the high-z star-forming dwarf galaxies thought to be responsible for the reionization of the Universe. We propose to observe with the HST/COS a sample of the six most metal-deficient (12+logO/H=6.98-7.23) compact SFGs known in the local universe, to obtain low-resolution spectra from Lyman-alpha to ~1700 Ang (covering e.g. the Lya, CIV 1550, HeII 1640, OIII]1661,1666 emission lines) of all XMDs. Only one galaxy with such a low metallicity, I Zw 18, has been studied previously with the HST/COS. These SFGs were selected from the Data Release 16 and earlier releases of the Sloan Digital Sky Survey to be not only XMD, but also to be very compact and to have very young starbursts (EW(Hbeta)=159-177A). Among them one galaxy, J0811+4730 with 12+logO/H = 6.98, is one of the lowest-metallicity low-z SFG known to date. The spectra will be used to constrain the properties of extremely metal-deficient massive stars, the ISM, and the radiation field of these objects, which are extremely rare in the local Universe, but were common at high redshift. Obtaining the rest-UV spectra of these six XMD SFGs which will serve as templates for the analysis of spectra of high-z dwarf galaxies with active star formation, is thus both urgent and crucial for upcoming studies with the JWST and the largest ground-based facilities.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 17101
Program Title: Clash of Titans: Characterizing SPT-CLJ0307-6225, a major merger in the plane of the sky

Principal Investigator: Zenteno, Alfredo

PI Institution: NOIRLab - CTIO (Chile)

Mergers of galaxy clusters are natural dark matter (DM) colliders. If DM particles self interact, signatures of the interaction can be found in merging clusters as an spatial offset among the collisionless cluster galaxies, the intracluster gas, and the cluster potential, dominated by the DM. Typically, to place constraints on the value of the DM particle self-interacting cross section, ensembles (~ 40) of merging clusters are used. Nevertheless, most of the constraining power comes from a special type of mergers: oriented in the plane of the sky, with (relatively) similar cluster masses, and showing a large displacement between the collisional and the collisionless components. Finding those special mergers would significantly improve the current constraints on the DM particle self-interacting cross section. SPT-CLJ0307-6225 is a merging cluster in the plane of the sky, with {\it Chandra} X--ray showing a comet like gas distribution, Gemini/GMOS and VLT/MUSE spectroscopy that confirms a plane-of-the-sky orientation of the merger, and ground based imaging confirming both, a large gas galaxy offsets (~ 790 and ~ 360 kpc) and the need for space base observations, for a robust weak lensing analysis. The superb imaging of HST will allow us to map the dark matter mass density distribution of SPT-CLJ0307-6225, and to use it to place constraints on the self-interacting DM cross section.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17102
Program Title: Anchoring CNO with Extremely Metal Deficient Galaxies

Principal Investigator: Berg, Danielle

PI Institution: University of Texas at Austin

While oxygen and nitrogen have been widely observed in spiral and dwarf galaxies, the study of the next most abundant element, carbon, remains relatively unexplored, especially for the lowest metallicities relevant for high-z galaxies. Carbon has no strong collisionally-excited emission lines in the optical, however, by observing the CIII] 1907,1909 and OIII] 1661,1666 emission lines in the UV, we can obtain a very secure measurement of the C/O ratio in HII regions. Recent campaigns have been successfully using this method to measure C/O abundances in dwarf galaxies using HST/COS, however, extremely metal poor galaxies (XMPs; 12+log(O/H) < 7.3 or < 3% solar) are notoriously rare and have challengingly faint emission, and so no significant measurements of C/O yet exist for the most metal-poor nearby galaxies. The recent discovery of unexpectedly strong ultraviolet OIII] 1666 and rare NIII] 1750 emission from the HST/COS G160M spectrum of nearby XMP galaxy, Leo P (12+log(O/H)=7.17), reveals a unique opportunity to measure the CNO abundances in a chemically-young, high-ionization galaxy with exceptionally bright emission. We propose HST/COS G140L observations of Leo P to simultaneously measure the C, N, and O abundance in the most metal-poor XMP to date. These observations will allow us to (1) anchor the C/O and C/N relationships by extending the low-metallicity baseline, (2) explore the potential continuity in C/O versus O/H from dwarf galaxies to DLAs, (3) test the proposed link between C and N production, and (4) help constrain rest-frame UV emission-line diagnostics in chemically-young systems in preparation for the distant galaxies that will be observed with JWST.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17103
Program Title: GO: Calibrating the Black-Hole Mass Scaling Relations using Reverberation-Mapped Active Galaxies with Velocity-Resolved Measurements

Principal Investigator: Bennert, Vardha

PI Institution: California Polytechnic State University San Luis Obispo

Reverberation mapping (RM) determines the mass of black holes (MBH) in active galactic nuclei (AGNs) by resolving the BH gravitational sphere of influence "in time". The resulting relationship between broad-line region (BLR) radius and AGN luminosity (the "R-L relation") is the foundation of virtually all MBH measurements beyond the local universe. Recent RM campaigns with high-quality data (cadence and S/N) yielded velocity-resolved time lags and independent BH masses for a sample of 29 objects, spanning a wide range of AGN luminosities and BH masses (6.4<log MBH/Msun<9.1). Integral-field spectroscopy was obtained with state-of-the-art instruments (Keck/KCWI and VLT/MUSE) for 11 objects for a robust measurement of stellar-velocity dispersion. HST images are essential to: (i) separate the nuclear luminosity from that of the host and thus calibrate the R-L relation over a wide mass range; (ii) determine the correlations between MBH and host-galaxy properties, such as bulge and host-galaxy luminosities, bulge effective-radii, and morphology (frequency of pseudo-bulges, bars, and mergers). Archival HST images are available for 18 objects (see our AR proposal ID 3094), we propose here for the remaining 11. This sample has the most accurate MBH measurements beyond the local universe and will provide a fundamental local benchmark for studies of the evolution of massive black holes and their host galaxies across cosmic time. Measuring the distribution and scatter of f factors and looking for other dependencies to go beyond the sample-average f factor will help to better constrain the single-epoch BH mass.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17104
Program Title: Repeated Stellar Wind Line Variability in O Stars in the SMC

Principal Investigator: Rickard, Matthew

PI Institution: University College London

Massive stars dominate the space surrounding them, as the source of ionising flux, by the feedback from their winds and from dramatic cataclysmic events such as supernova. Understanding the physics of massive star winds is critical to various fields of astrophysics. A large area of tension is the so-called weak wind problem, with measured mass-loss rates from stellar winds from late O stars being lower than hydrodynamical predictions. In particular, it is suggested that the weak wind problem affects earlier O types within the low-metallicity galaxies, such as the SMC, compared to the Milky Way. However, for low-metallicity stars, these conclusions are based on only a very small number of analyzed stars. By inspecting the archival UV spectra of the commonly cited stars, we find that the wind lines of these stars are often variable. This variability appears to be cyclic, and hence resembling the ambiguous variability observed in Galactic O stars on time scales comparable to the rotational periods. This cyclic variability is commonly explained by the presence of large scale co-rotating structures within stellar winds. In low metallicity stars, this type of variability has never yet been studied but is urgently needed. We propose a highly efficient series of long slit UV spectrograph observations of seven late O type stars in NGC 346, the most massive star cluster in the SMC. Taken over 15 orbits, these observations will be equally spaced to monitor the variability of the CIV doublet 1548.2 - 1550.8 wind lines over multiple rotation periods of the targets. This will finally resolve questions about the structure of stellar winds at low metallicity.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17105
Program Title: Monitoring the Evolving Winds in the Active Galaxy Mrk 817

Principal Investigator: Kriss, Gerard

PI Institution: Space Telescope Science Institute

Characterizing the structure and kinematics of the gas surrounding supermassive black holes at the centers of galaxies is crucial for understanding accretion and black-hole growth, as well as outflows and associated feedback for host-galaxy evolution. Intensive, successful reverberation mapping campaigns with HST on the active galactic nuclei (AGN) of NGC 5548 (Cycle 20) and Mrk 817 (Cycle 28) have revealed a wealth of information on the structure of their broad-emission-line regions (BLR), their accretion disks, and the new, unexpected obscuring outflows visible in their X-ray and far-UV spectra. The BLR of these AGN are dominated by virial motions, and the obscuring outflows play a significant role in regulating the ionizing flux reaching the BLR gas. Although HST observations of Mrk 817 are complete, continued monitoring in X-ray, UV, and optical with Swift (2 years, every other day), NICER (1 year, every other day), and ground-based observatories have been approved and are ongoing (private communication). To take advantage of these multi-wavelength programs, we propose to continue observing Mrk 817 with COS, with a cadence of one orbit per month throughout Cycle 30. Our primary science goal is to monitor the continued evolution of the obscuring outflow, perhaps even watching as it dissipates; measure its continued impact on the characteristics of the BLR; and, via a triggered observation, do a comprehensive broad-band evaluation of the state of Mrk 817's accretion disk and broad emission-line properties once the obscuration has melted away.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17106
Program Title: A Novel View of Local Star-Forming Galaxies With COS

Principal Investigator: Leitherer, Claus

PI Institution: Space Telescope Science Institute

We propose COS G130M (1096) observations of nine ultraviolet-bright star-forming galaxies lacking HST spectroscopy in the 950 - 1150 A wavelength regime. Our strategy is a dual approach to unveil the complex star formation histories of these galaxies which have archival large-aperture FUSE and longer-wavelength COS spectroscopy. Extending the existing COS coverage down to 950 A yields (i) panchromatic COS spectroscopy with matching apertures, and (ii) same-wavelength spectroscopy with large (FUSE) and small (COS) apertures. The galaxies were selected to cover a representative range of morphology, luminosity, chemical composition and distance. The new data will open a new spectroscopic window that has not been explored in detail with HST. Comparison with FUSE spectra will allow a study of the scales of star formation over areas differing by factors of 150. The 950 - 1150 A wavelength region contains stellar and interstellar spectral lines complementing and expanding the diagnostics at longer wavelengths. In particular, the strong O VI 1035 doublet with an ionization potential of 114 eV probes the highest energies powered by stellar winds. We will test and calibrate this line as a tracer of massive stars. In combination with available HST and other data we will investigate the star-formation history, the kinematics of the interstellar medium, and the effects of dust attenuation, including the reddening law down to near the Lyman break.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17107
Program Title: A very low mass, highly irradiated survivor of the common envelope phase

Principal Investigator: Marsh, Tom

PI Institution: The University of Warwick

The common envelope (CE) phase is a key driver in the evolution of close binary stars, causing their periods to shrink dramatically, or the two stars to merge altogether. An important parameter for the survival of many systems, including planets enveloped by host giant branch stars, is the minimum companion mass that can survive a CE. No certain survivor of a CE has been found with a mass less than 50 Jupiter masses (M_J), well above the lowest theoretical prediction of 5 M_J. With the theory itself uncertain, it is important to establish firmer observational limits. A recently discovered hot white dwarf / brown dwarf binary with a period of 2.4 hours promises to do just this. Optical data of this system indicate a mass for the brown dwarf lying between 11 and 44 M_J. Better constraints require a measurement of the temperature of the hot white dwarf, which translates to a better mass for the brown dwarf through a combination of distance, model atmosphere, gravitational red-shift and dynamical constraints. Preliminary indications from optical spectra suggest a white dwarf temperature of order 100,000 K and a brown dwarf mass of order 20 M_J, substantially reducing the current gap between theory and observation. However, optical spectra have relatively few and weak features compared to the FUV, and suffer significant contamination from light emitted by the heated face of the brown dwarf in this compact system. The aim of this proposal is to acquire FUV spectra to measure the white dwarf's effective temperature and to obtain improved values for the dynamical and red-shift constraints upon which the mass estimates hinge.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17108
Program Title: Dissecting Early Universe Dust with Matched-Resolution Observations from HST, JWST, and ALMA

Principal Investigator: Spilker, Justin

PI Institution: Texas A & M University

We propose deep ACS and WFC3 imaging of two IR-luminous lensed galaxies at z~4 with 0.04-0.08" imaging of the dust emission from ALMA and approved panchromatic JWST imaging and IFU spectroscopy through the TEMPLATES Early Release Science program. These objects will immediately become some of the best characterized galaxies at high redshift, observed in virtually all typical SFR tracers at resolutions far beyond the unlensed diffraction limit. HST is the only facility capable of detecting and resolving the rest-UV emissions, filling a critical gap in existing data. The arrival of JWST imaging and spectroscopy later this year will enable comparisons of the distribution of star formation, stellar mass, stellar age, small and large dust grains, and other properties on highly resolved scales. Even without JWST, the HST data alone will allow for an unprecedented comparison between unobscured and obscured star formation traced by HST and ALMA on scales of 100-200pc. The HST data will allow us to place these objects in the context of the IRX-beta relation on spatial scales an order of magnitude finer than existing case studies, revealing whether and on what spatial scales geometric effects lead these dusty galaxies to fall far from the standard relations. The imminent addition of comprehensive JWST data will allow us to test key assumptions in widely-used SED fitting codes and the effects of spatial resolution on recovered properties. These observations complement substantial investments of JWST and ALMA time, have high legacy value, and we waive the HST exclusive access period to allow the community to benefit from these unparalleled HST+JWST+ALMA datasets.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17109
Program Title: Lyman continuum leakage in z~0.3 - 0.4 dwarf compact star-forming galaxies with very low metallicities

Principal Investigator: Izotov, Yuri

PI Institution: Ukrainian National Academy of Sciences, BITP

One of the key questions in observational cosmology is the identification of the sources responsible for cosmic reionization. The general consensus is that a population of faint low-mass and low-metallicity galaxies must be responsible for the bulk of the ionizing photons at high redshifts. However, for a long time, attempts at identifying individual galaxies showing Lyman continuum (LyC) leakage have only found very few such galaxies, both at high and low redshifts. A breakthrough was achieved in the last few years by Izotov et al. (2016ab,2018ab,2021), who detected LyC emission in 15 out of 20 low-z (z~0.3) compact star-forming galaxies (SFG) with LyC escape fractions of 2-72%, using HST/COS observations. Furthermore, a Large Program of COS observations of 66 z~0.3-0.4 SFGs with the LyC detections in ~50 SFGs has been completed. However, almost all these SFGs have 12+logO/H>7.7, while it is expected that lower-metallicity galaxies were the main sources of the reionization of the Universe. It is proposed here to extend the previous studies to a sample of eight compact SFGs at z~0.3-0.4 at lower metallicities 12+logO/H~7.45-7.70 derived by a direct method, a range almost not explored before by HST/COS. This will allow us to study how LyC escape varies with metallicity in a larger range. The observations will also allow for the determination of the Ly-alpha line profile, providing an empirical probe of this robust indirect LyC leakage indicator for a wide range of metallicities. Since these low- metallicity compact SFGs share many properties with typical SFGs at high redshift, this study will provide important insight on the sources of reionization of the early Universe.

Proposal Category: SNAP
Scientific Category: Galaxies
ID: 17110
Program Title: Post-starbursts from DESI: Timing quenching and morphological transformation at $1 < z < 1.3$

Principal Investigator: Setton, David

PI Institution: University of Pittsburgh

Studies of post-starburst galaxies that combine deep imaging and high-quality spectroscopy have led to an increased understanding of the relationship between merging, structural transformation, and quenching. Imaging allows for detailed structural studies of galaxies, while optical spectra enable precise timing of the cessation of star formation; the combination can distinguish between quenching mechanisms. However, at z>1, when quenching of massive galaxies was much more common, we still lack comprehensive datasets that provide both for the rare but crucial PSB population. We propose to create that data set with a WFC3/F110W SNAPSHOT program targeting ~100 z>1 PSBs selected from the DESI Survey Validation sample of Luminous Red Galaxies. We will measure sizes, identify merger rates, and ultimately study the evolution of the population of recently quenched galaxies as a function of the time since quenching, as derived from the spectra. Only by combining the resolution of HST with the deep spectra we have in hand can we reveal the conditions that led to quenching in these massive galaxies.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17111
Program Title: The winds of massive stars at the peak of the star formation history of the Universe

Principal Investigator: Garcia, Miriam

PI Institution: Centro de Astrobiologia (CSIC/INTA) Inst. Nac. de Tec. Aero.

Massive stars are powerful sources of ionizing radiation and kinetic energy that shape the interstellar medium and the UV spectral morphology of host galaxies. Their life-averaged feedback and their end as SN/GRB make them fundamental ingredients to galactic chemodynamical evolution models and population synthesis codes. Feedback from massive stars is not constant along the history of the Universe: their evolution and pre-SN core size is determined to a large extent by radiation-driven winds, and these depend strongly on metallicity. In a Universe of ever-increasing metal content, metal-poor massive stars and their winds are a central piece to study star-forming galaxies in past cosmic epochs. The HST archive, supported by the ULLYSES DDT program, stores a large collection of UV spectra of massive stars in the Milky Way and the Magellanic Clouds that will enable a thorough characterization of radiation-driven winds down to metallicities of 1/5 Zsun. Yet, this value is not representative of the composition of the Universe earlier than redshift=1, nor at such an important landmark as the peak of the Cosmic star formation history (redshift~2). We request HST-COS UV spectroscopy of 4 OB-type stars in Sextans A, with 1/10 Zsun metallicity, akin to blue massive stars of that period. The selection has been crafted to cover uncharted parameter space in the upper HR-diagram, where radiation-driven winds are expected to be significant. Quantitative analysis of this sample together with archival data will allow us to characterize radiation-driven winds at very low metallicity and to produce the first prescriptions to be implemented into models of stellar evolution.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17112
Program Title: A Treasury FUV Survey of the Hottest White Dwarfs

Principal Investigator: Reindl, Nicole

PI Institution: Universitat Potsdam

Hot white dwarfs (WDs) represent the beginning of the end of the vast majority of stars. They are key objects to reconstruct the various evolutionary pathways of sun-like stars and serve as powerful tools to address a multitude of (astro-)physical questions. However, the physics operating in the hottest (Teff>50kK) WDs remains poorly to hardly understood, since several investigations on these short-lived stars rely on low-number statistics. Progress can only be made with further high-resolution FUV spectra uniquely allowing reliable Teff and metal abundances determinations. Gaia and extensive spectroscopic follow-up has now allowed us for the first time to assemble an all-sky sample of the brightest and hottest WDs, suitable for follow-up with the HST. The proposed Treasury program will triple the number of high-resolution FUV spectra of WDs in the enormous Teff interval 50-200kK and be precious to a broad scientific community. Key science cases are: (1) Map metal abundance patterns along the early WD cooling sequence to decrypt several phenomena occurring during that stage (2) Provide powerful observational constraints to test theoretical diffusion, planet accretion, and wind models, as well as stellar evolutionary calculations (3) Assess systematic errors on Teff introduced by optical spectral analysis only, and by that calibrate our stellar atmosphere and binary light curve models that will be applied to thousands of hot WD from upcoming surveys (4) Identify (hitherto undetected) trans-iron elements to uncover opacity sources and to derive atomic data, which will allow to investigate heavy elements in hot stars in general

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17113
Program Title: Simultaneous detection of Mg, C and O to trace dust and ices in exocomets of the young system HD172555

Principal Investigator: Lecavelier des Etangs, Alain

PI Institution: CNRS, Institut d'Astrophysique de Paris

HD 172555 is a young planetary system embedded in a warm gaseous debris disk seen edge-on. A stable gas component and transiting exocomets can be observed in details using absorption spectroscopy. Several variable absorption features identified as due to transiting exocomets have been detected in the optical and UV spectra. HST COS and STIS observations revealed the presence of highly ionized species, ionized carbon and neutral oxygen in the cometary gaseous tails. Nonetheless, the limited wavelegnth coverage of available HST observations of HD172555 precludes from detecting refractory species simultaneusly with volatile elements, which is needed to determine if these star-grazing evaporating bodies are volatile-rich or not. Here we propose to probe the dust-to-ice ratio in transiting exocomets of HD172555. This objective can be achieved by capturing exocomet signatures simultaneously in MgII, CII and OI lines with COS/FUV and STIS/NUV spectra of this young star. Magnesium is one of the main constituant of silicate (forsterite, enstatite), while carbon, oxygen and CO are among the main species forming ices in comets. The dust-to-ice ratio will be given by the simultaneous measurement of absorption signatures of these key species. The number of visits has been choosen to warranty the detection of at least one exocomet transit, at a 95% confidence level. After Beta Pictoris, this will be the second extrasolar system for which it will be possible to measure this important ratio tracing the condensation and evaporation processes. The determination of the gas/dust ratio is a key measurement to trace the origin and formation place of minor bodies in a planetary systems.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 17114
Program Title: Four New Dissociative Merging Clusters

Principal Investigator: Wittman, David

PI Institution: University of California - Davis

We propose ACS imaging of four exciting new merging clusters with ``dissociative'' morphology---two galaxy subclusters on either side of a central gas concentration, indicative of a recent head-on collision. The imaging will enable a weak lensing analysis that will (i) determine the dark matter halo locations relative to the galaxy subcluster locations; (ii) measure the subcluster masses; and (iii) place limits on the presence of any additional substructures. In conjunction with existing X-ray data and a scheduled spectroscopic survey, the dark matter halo locations and masses will enable accurate modeling of the merger scenario. Upper limits on galaxy-dark matter offsets will be translated to upper limits on the momentum exchanged between the dark matter halos. Together with accurate modeling of the merger scenario, this will place upper limits on the dark matter scattering cross section. These four systems are promising in that respect because their modest separations suggest that they are seen not long after first pericenter.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17115
Program Title: The Circumgalactic Medium of Dwarf Galaxy Pairs

Principal Investigator: Bowen, David

PI Institution: Princeton University

We propose obtaining COS G130M spectra of QSOs lying behind dwarf galaxies (with stellar masses of log[M*(M_solar)] < 9.0) to study the absorption lines that the galaxies' circumgalactic medium (CGM) produces along the sightlines to the background probes. The galaxies are selected to lie at low redshifts so that a range of techniques can be used to complement the results from the absorption line spectroscopy (such as 21 cm emission line mapping). We define two samples of dwarf galaxies: (a) SINGLE isolated dwarf galaxies and (b) PAIRS of isolated dwarf galaxies. For both samples, we aim to determine the extent of the neutral and metal-enriched CGM around the galaxies, search for changes in the phases of the CGM with distance from the galaxies, and measure, when possible, the metallicity of the CGM. A principal goal is to examine whether the CGM of dwarf galaxy pairs is different from that of single dwarf galaxies; that is, we aim to use the sample of single dwarf galaxies as a control sample for the pairs of dwarf galaxies. This comparison will enable us to examine whether interactions between dwarf galaxies lead to substantial amounts of baryons being `parked' in the outskirts of their CGM, acting as reservoirs that fuel their star formation (SF). A direct comparison between the properties of the CGM of the dwarf galaxy pairs with the single dwarf galaxies will demonstrate whether the CGM is dominated by tidal interactions or, instead, by outflows of gas instigated by the SF that the interactions ignite.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17116
Program Title: The Hot Multi-Temperature Gaseous Halos of Galaxies and Groups

Principal Investigator: Bregman, Joel

PI Institution: University of Michigan

Less than one-third of the baryons in a galaxy are in the stars and gaseous disk, with the rest being in a gaseous halo region that may extend to or beyond R_200. According to models, this is because feedback from stars heats the halo gas, shaping galaxy evolution and regulating star formation today. Most of the extended gaseous mass is near the virial temperature, ~10^6.3 K for L* galaxies, and this gas is measured by the O VII and O VIII lines in the X-rays. The other essential halo gas property is the net cooling rate, measured from the O VI line, which carries the cooling as it passes through the ~10^5.5 K range. These lines define the most important aspects of halo gas models -- a cooling flow with feedback. The X-ray lines in external galaxies will be measured with future X-ray observatories, such as Athena or Arcus, while only HST-COS can measure the O VI line. This proposed legacy program will nearly triple the redshift space for which all three lines will be observed along the same sightlines, producing about 30 absorption systems. This will provide enough statistical power to determine halo properties, including the feedback efficiency, metallicity, and departures from steady state.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17117
Program Title: A complete census of quiescent galaxies in the dense core of the Spiderweb protocluster at z=2.16

Principal Investigator: Koyama, Yusei

PI Institution: National Astronomical Obs of Japan (NAOJ), Subaru Telescope

We propose deep (7-orbit) WFC3/IR G141 spectroscopy of the central region of the best-studied galaxy cluster in formation - the "Spiderweb" protocluster at z=2.16 - to blindly search for and characterize quiescent members in the dense core of the protocluster. We will measure the stengths of the 4000A break (Dn4000) and the equivalent widths of the H-delta absorption line for all cluster member galaxies in the single WFC3 FoV (~1.5cMpc x1.5cMpc). This enables us to determine the formation redshifts (z_f) of individual cluster members and identify recently quenched galaxies (post-starbursts), allowing us to test if massive cluster galaxies are formed at much earlier epoch (at z>>4), or if a majority of them are recently quenched. Importantly, in addition to the rich multi-wavelength datasets collected over the last ~20 years, the scheduled JWST/NIRCam Cycle-1 GO program and ALMA Cycle-8 program for wide-field 1.1mm mapping will unveil the obscured star-formation in the Spiderweb protocluster through Paschen-beta and dust continuum. By mapping the internal distribution of star-forming and quenched/quenching pixels within the protocluster members - our ultimate goal is to reveal how the quenching event is triggered and propagated within massive cluster galaxies. Do the quenched region always propagate in an inside-out fashion? Or, does it happen simultaneously throughout the disk? The proposed WFC3 observations are critical to identify the quiescent members, and with the scheduled JWST observations, we will finally have a complete census of all cluster members of this structure at the peak epoch of star-formation, black hole and molecular gas activity.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17118
Program Title: Taming the BEAST of N66 to resolve how star formation shapes the interstellar medium at low metallicity

Principal Investigator: Murray, Claire

PI Institution: Space Telescope Science Institute

Although galaxies evolve by assembling the interstellar medium (ISM) into stars, standard gas tracers fail to account for the total ISM mass available for star formation. This is especially true at low metallicity and in strong radiation fields where dust shielding and dense molecular gas are scarce. Dust provides an independent tracer across phases, but its basic properties -- mass, grain size and extinction curve -- are poorly constrained between diverse environments. We propose to survey N66, the largest star-forming region in the low-metallicity Small Magellanic Cloud (SMC) with optical and ultraviolet imaging from Wide Field Camera 3. Along with archival imaging in the optical and IR from HST and JWST, we will constrain the intrinsic properties of resolved stars and the intervening dust independently from systematics of IR emission surveys and at 10x higher resolution. We will (1) quantify the influence of ionizing radiation fields on fundamental dust properties (2) map the ISM mass independently of emission systematics to quantify the nature of ``dark'' gas at low metallicity. HST is the only observatory with the superb resolution and UV sensitivity necessary for these objectives, and N66 is the perfect laboratory for quantifying the influence of star formation activity on the structure of the ISM in the SMC, an excellent prototype for galaxies in the distant Universe.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17119
Program Title: Completing the stellar census of Westerlund 1

Principal Investigator: Konopacky, Quinn

PI Institution: University of California - San Diego

We propose to obtain a new epoch of precise astrometry covering a 4'x4' extent of the massive, young cluster Westerlund 1. Previous epochs of HST data have been used to determine cluster membership for the full cluster down to a mass limit of 1.4 Msun using proper motions derived from a combination of optical and near infrared data. By adding an additional epoch of astrometry from WFC3-IR, we will be able to confirm the full membership of the cluster down to 0.1 Msun. These observations will be used to map the full initial mass function (IMF) of the cluster, which we have tentatively found is bottom-light. Furthermore, the additional epoch of data will offer an improvement in proper motion precision by a factor of 3, enabling the measurement of velocities to ~1 km/s. Using this information, we will map the velocities as a function of mass to test star formation models. These data will provide new insight into the origin and universality of the IMF.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17120
Program Title: Are all massive Kuiper belt objects built the same?

Principal Investigator: Melis, Carl

PI Institution: University of California - San Diego

We have identified GaiaJ0628-5054 as a single, polluted, white dwarf star that is accreting extremely oxygen- and hydrogen-rich material that is otherwise depleted in all other rocky elements, suggesting that it is being polluted by a massive icy body. Similarities with the hitherto unique extrasolar Kuiper belt object-ingesting WD1425+540 suggest GaiaJ0628-5054 is being polluted by what could be a rare second example of an extrasolar Kuiper belt object. We propose COS FUV spectroscopic observations of GaiaJ0628-5054 that will allow us to confirm our interpretation and then explore the range of rocky mass fractions for extrasolar Kuiper belt object analogs. These observations will have immediate value in assessing the validity of internal structure models for Pluto, Charon, and Arrokoth by providing a contrast of New Horizons interpretations for outer solar system bodies against what is observed in other planetary systems.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17121
Program Title: Probing the Gas in and around Local Galaxies Mapped with Integral Field Spectroscopy

Principal Investigator: Kulkarni, Varsha

PI Institution: University of South Carolina

An important question in understanding galaxy evolution is how the gas in the galactic disk, bulge and halo couples with the circumgalactic medium (CGM). Here we propose to study the multi-phase gas in and around 18 local galaxies (z<0.1) whose inner regions have been mapped in exquisite detail with integral field spectroscopy (IFS). To probe the warm and cool gas, we propose COS UV spectroscopy of background AGNs whose sight lines pass through the halos of the targeted galaxies. Our observations will allow us to combine the wealth of detailed maps already available for these galaxies from MaNGA with the physical diagnostics (e.g., metallicity, ionization, kinematics) of the multiphase gas that can be inferred robustly only from UV absorption-line spectroscopy. Our goals are to (1) measure element abundances in the cool gas from absorption lines and compare to ionized gas metallicity from MaNGA; (2) measure the composition of the warm, ionized gas and examine whether its velocity is sufficient to escape the galaxy; (3) determine whether gas metallicity and galaxy-absorber azimuthal angle are correlated (e.g. whether lower metallicity is seen along the major axis); (4) compare the cool gas kinematics with ionized gas kinematics, e.g. does the cool gas lag behind the galaxy's mid plane as the ionized gas does. Our study will shed light on how the inner and outer regions of galaxies interact; e.g., how gas, metals, and angular momentum are exchanged between different regions. Our program will greatly enhance the power of the MaNGA data for studies of galaxy formation and evolution. HST is essential because of the need for UV spectroscopy.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17122
Program Title: Testing Planetary Formation Mechanisms through the First FUV - Optical Spectrum of a Young, Accreting Planet

Principal Investigator: Robinson, Connor

PI Institution: Amherst College

A new method of studying the formation history of exoplanets has recently become available through observations of accretion signatures in young substellar systems. We propose to obtain the first spectrum of a young, accreting planetary mass companion spanning FUV to optical wavelengths. This unprecedented measurement will enable us to calibrate substellar accretion diagnostics by directly measuring the NUV accretion continuum excess and probing the structure of the planetary accretion shock through FUV emission lines. The ideal target for these measurements is Delorme AB(b), a nearby, widely separated, young planetary-mass companion with a moderate accretion rate. Growing evidence of deviation at low masses above the empirical mass-mass accretion rate relationship established for stars suggests that substellar companions may form through disk fragmentation rather than core collapse. However, models of substellar accretion shocks differ in several fundamental ways from those designed for the stellar magnetospheric accretion paradigm. This suggests that the current stellar-derived, ground-based (e.g., optical/IR emission lines and the Balmer jump) accretion diagnostics may not be suitable for planets and brown dwarfs. Our proposed observations are critical to test these scenarios and improve our understanding of the substellar accretion process and the formation mechanisms of planets and brown dwarfs.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17123
Program Title: Characterizing four massive post-interaction binaries with HST/COS

Principal Investigator: Goetberg, Ylva

PI Institution: Carnegie Institution of Washington

Massive stars stripped of their hydrogen-rich envelopes should be one of the most common types of binary products and the progenitors of stripped-envelope supernovae and binary neutron star mergers. Yet, no such system descending directly from stable mass transfer has been published. We propose to characterize a set of four binaries containing ~2-5 Msun stripped stars (originating from stars with initial masses ~7-20 Msun) that orbit B-type companions and that were recently discovered in the Large Magellanic Cloud. Because stripped stars are the exposed helium cores of their progenitors, they are very hot and emit most of their light in the ionizing extreme ultraviolet. As a result, their main-sequence companions dominate the optical output, making HST/COS UV spectroscopy necessary for characterizing the properties of the stripped stars. Using a set of HeII and HI lines combined with NIV and NV lines in the UV, we will be able to measure the effective temperature, surface gravity, surface hydrogen/helium content, and wind mass loss. In turn, these will lead to estimates for the bolometric luminosity, stellar radius, and mass. Combined with the properties of the companion star, we will provide the first stringent constraints on the outcomes of stable mass transfer in massive binary stars.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17124
Program Title: High Resolution Spectroscopic Mapping of Mass Loss in Luminous Blue Variables

Principal Investigator: Bruhweiler, Frederick

PI Institution: American University

High-resolution (R~110,000) HST UV spectra of the very massive LBV, eta Car, reveal interstellar-like extremely narrow, discrete absorption components with line widths ~5 km/s arising from transitions from ground configurations and metastable levels up to 40,000 cm-1 of Fe-group ions.These features, seen at high negative velocities, arise in dense gas in the near circumstellar environment of eta Car. The implied densities, at least 10^7-8 cm-3, are highly uncharacteristic of the normal ISM. They appear to have originated from clumping in mass outflow of eta Car. IUE spectra show clumping in wind features of other LBVs and has been confirmed by optical observations of Ca II and Fe II. High-resolution UV STIS spectra coupled with proper photoionization modeling offers the only means to detect these extremely narrow absoptions and determine the physical conditions, and line-of-sight distribution (distance from the star) of the ejecta producing the extremelly narrow absoptions. Knowledge of ejecta velocities and distances will permit us to construct a time history for the ejection events. We will obtain and analyze the first high-resolution HST UV spectra of three LBVs having typical masses, and perform the same analysis on archival Eta Car spectra. This information will have many implications for aspects of LBV mass loss, evolution, and wind mechanisms that are not yet understood.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17125
Program Title: Sharpening our High-z Toolset: Spatially Resolving UV Emission Line Diagnostics Throughout Pristine Gas

Principal Investigator: James, Bethan

PI Institution: Space Telescope Science Institute - ESA - JWST

It is imperative that we enter the high-z era with a diagnostic toolset that enables us to decipher the chemical and physical conditions of a galaxy using primarily UV emission lines. Moreover, this toolset needs to be most effective in typical high-z environments (low metallicity, hard ionising fields). Unfortunately, current efforts to derive such a toolset suffer from severe paucity in the extremely metal-poor (XMP) regime (<5% Zsol), and - most importantly - globally integrated spectra that are prone to large observational biases. Local high-z analogs are rare, particularly in the XMP regime, and very few allow us to examine how integrated spectra can bias the derived diagnostics. Here we have a unique opportunity to solve these issues by observing 5 individual HII regions throughout a chemically inhomogeneous, XMP star-forming galaxy, DDO68, with HST/COS, covering all of the key UV diagnostic lines (CIV, HeII, OIII], & CIII]). Each region has MOS optical spectroscopy, providing the first spatially resolved UV-to-optical coverage across a range of metallicities and ionizing field strengths. The HII regions provide independent samples within DDO68 to accurately calibrate UV lines using photoionization models for individual ionized nebulae, unlike integrated light studies. This exquisite dataset will allow us to first understand the physical properties driving UV lines, then harness this knowledge to provide stand-alone UV diagnostics for metallicity, density, and ionization source. Our parameter space ensures that we can accurately calibrate the UV diagnostics in a range of primordial-like environments, thereby providing the best UV toolset possible for the high-z era.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17126
Program Title: An HST Treasury of Stellar Feedback in Action: Sizes, Structures, and Power Sources for 50,000 Extragalactic HII Regions

Principal Investigator: Chandar, Rupali

PI Institution: University of Toledo

We propose a Treasury Halpha (F657N) imaging survey that will measure the sizes (radii) and structures (e.g. shell fraction) for >50,000 nebulae, including HII regions, supernovae, and planetary nebulae across the full range of galactic environments in 19 nearby main-sequence galaxies. These targets form a representative sample of massive, star-forming galaxies, and these proposed observations, only possible with the HST, will complete a rich dataset of i) VLT/MUSE IFU, providing spectroscopic information for all identified nebulae; ii) multi-filter broad-band HST imaging of >40,000 clusters, iii) ALMA spectral line mapping of >20,000 molecular clouds; and iv) >100 hours of upcoming near- and mid-IR imaging from JWST probing dust emission and embedded star formation. Together these maps and higher-level data products are crucial for answering: (1) What is the dominant mechanism for pre-SNe stellar feedback? (2) On what timescales do young clusters clear their birth-clouds? (3) What processes are responsible for cloud destruction? (4) What role does escaping radiation play in larger-scale galactic evolution? Taken together, the products obtained as part of this Treasury program will provide the definitive high resolution view of HII regions in nearby galaxies, essential to answer questions fundamental to our understanding of star formation and stellar feedback. These observations are needed now to form a crucial part of Hubble's lasting legacy.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17127
Program Title: Testing models of accretion onto the Young Planetary System PDS 70

Principal Investigator: Aoyama, Yuhiko

PI Institution: Tsinghua University

Observations of the planet-forming regions have revolutionized our understanding of how planets formed in the past decade. Of the many advances, the PDS 70 system is unique -- a system hosting two giant plants that are still growing from proto-lunary disks. When trying to understand the mass assembly of giant planets, such as PDS 70 b and c, this growth rate is a fundamental property. Typically the accretion rate is estimated by measuring H-alpha and then converting the line luminosity into accretion luminosity. However, this conversion was developed for the case where H-alpha emission is produced in the magnetospheric accretion flow. For forming planets, the magnetospheric accretion flow may not be hot enough to emit hydrogen lines. If the H line emission is instead produced by the accretion shock, more than half of the energy would escape as Ly-alpha photons. This uncertain interpretation leads to large errors in estimates of accretion rates from the observed H-alpha line. In this proposal, we request deep HST/ACS SBC PR130L prism spectra of PDS 70b and c to confirm whether the magnetospheric accretion flow emits hydrogen lines. We will use H2 emission, photoexcited by Ly-alpha photons, to compare Ly-alpha emission to H line emission. In addition, we will measure the C IV line luminosity and place it in the context of accretion flows onto low-mass stars and brown dwarfs. These observations will allow us to understand accretion onto PDS70 b and c and prepare to apply these models to the characterization of future discoveries with JWST and the ELTs.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 17128
Program Title: Reducing Type Ia Supernova Distance Biases by Separating Reddening and Intrinsic Color

Principal Investigator: Foley, Ryan

PI Institution: University of California - Santa Cruz

Accurate distance measurements and unbiased cosmological constraints from Type Ia supernovae (SNe Ia) rely on proper correction for host-galaxy dust reddening that may attenuate the observed SN brightness. A correction is made by comparing observed and intrinsic color, and using a reddening law to determine extinction. This procedure is nontrivial since a SN's intrinsic color correlates with its luminosity in a manner nearly indistinguishable from the effects of dust reddening at optical wavelengths. The current standard for measuring SN distances treats both fainter-redder relations as a single SN color law. This simplification introduces a bias that depends on the relative contribution of each component. If dust properties change with galactic environment or redshift, equation-of-state parameter measurements may be biased by up to ~6%. This issue is currently SN cosmology's largest systematic uncertainty and if not addressed will prevent future cosmology experiments from meeting their goals. The path to breaking the degeneracy between SN color and dust reddening is to extend observations to the UV and NIR, where the dust and intrinsic color, respectively, dominate the observed color. We propose to image 100 SNe across 2 UV, 1 optical, and 4 NIR bands in a single orbit each at a phase in a SN's evolution where the observed color scatter is small and is late enough to use non-disruptive ToOs. Simulations indicate this sample will be sufficient to constrain the environmental dependence of the dust law and reduce the size of dust/color-related systematic uncertainties to be subdominant even for future cosmological analyses with the Nancy G. Roman Space Telescope.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17129
Program Title: Hot stars in the stellar evolution laboratory IZw18

Principal Investigator: Oestlin, Goeran

PI Institution: Stockholm University

The extremly metal-poor star forming galaxy IZw18 is a key laboratory for galactic and stellar evolution studies. Deep HST V- and I-band imaging has revealed an underlying population, and determined its distance through observations of cepheids and the tip of the red giant branch. It will soon be targeted by JWST/NIRCAM and MIRI to provide a complete census of evolved red stars and young stellar objects. However, deep imaging in the blue and ultraviolet which is where the young massive stars are the brightest and are best studied is lacking, which we here propose to remedy. By deep far UV to blue imaging in 4 filters a census of the hot star population in IZw18 and the extinction law at very low metallicity would be obtained. With the exquisite spatial resolution of HST and using the HeII 4686 narrow-band filter, we can, for the first time, identify what sources are responsible for the HeII emission including Wolf-Rayet stars, but also hard ionizing sources, such as rapid rotators, binary stripped stars, or accreting compact objects, and provide constraints on stellar evolutionary theories at low metallicity. The observations would also allow a much improved determination of the recent star formation history, and a chararacterisation of the luminous red stars that JWST will see.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 17130
Program Title: A 4% determination of the Hubble constant from gravitational time delays with maximally flexible lens mass profile

Principal Investigator: Treu, Tommaso

PI Institution: University of California - Los Angeles

Despite years of scrutiny, the measurement of H0 from SH0ES is still at 5-sigma tension with early-Universe probes. If the 8% difference is real it implies physics beyond LCDM. It is essential to develop independent methods with sufficient precision and accuracy to confirm or rule out the tension. A number of collaborations used gravitational time delays to measure H0 to 2% precision assuming that the mass density profiles of massive elliptical galaxies are described by a power-law or stars + Navarro Frenk White dark matter halos. However, if the assumption is relaxed under the mass sheet transformation, the precision of H0 from time delays drops to 8%. We propose to obtain a 4% measurement of H0 (sufficient to distinguish SH0ES and Planck at 2-sigma) from time delays, by replacing mass profile assumptions with empirical information, obtained from a sample of 24 galaxy-galaxy lenses selected to match the deflectors of the time delay lenses in terms of redshift, velocity dispersion, and effective radius. While all other data are in place, deep and sharp imaging is missing: 10 systems lack HST images, while the archival HST snapshots are undithered and too shallow for 12 of them. We will obtain single-orbit F475X images with sufficient signal-to-noise ratio and sampling to meet our goal. In addition, this proposal will serve as path finder for time delay cosmograpy in the era of the Euclid, Roman and Rubin Telescopes. Roman and Rubin will discover and image thousands of galaxy-galaxy lenses. Extracting and applying the information from galaxy-galaxy lenses will vastly accelerate the achievement of a 1% determination of H0 from gravitational time delays.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17131
Program Title: DDO68 C: the actual appearance of a ghost satellite dwarf

Principal Investigator: Annibali, Francesca

PI Institution: INAF-OAS Bologna

Extremely metal-poor galaxies (XMPs) in the local Universe are of fundamental interest since they provide a window on conditions similar to those of primordial galaxies. An iconic example of a nearby XMP is the gas-rich dwarf DDO68, at ~13 Mpc distance, with a metallicity of ~3% solar, discrepantly low compared with its relatively large stellar mass of 10^8 Msun. What makes DDO68 even more exceptional is the presence of two confirmed interacting satellites and a third candidate, dubbed DDO68-C, with a systemic HI velocity similar to that of DDO68, but with no confirmed distance. Indeed this "ghost" satellite has been poorly studied so far because of the presence of a bright foreground star close to its line of sight, thus very little is known about its stellar mass and stellar population. We propose to image DDO68-C for the first time with ACS/WFC in F606W (V) and F814W (I) to resolve its individual stars and derive its distance through the tip of the red giant branch. With a new robust distance for DDO68-C, the ACS data will allow us to also infer its star formation history, stellar mass, and constrain its metallicity through comparison of the empirical (V,I) color-magnitude diagrams with synthetic ones. These results will serve as input to N-body hydrodynamical simulations aimed at reconstructing the merging history of DDO68 with its satellites, and at possibly explaining its extremely low metal content. If DDO68-C turns out to be at the same distance as DDO68, this system would be a unique case of a dwarf interacting with three satellites, challenging the predictions from cosmological models for the satellite population around galaxies with the mass of DDO68.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17132
Program Title: The First Early FUV Observations of a Type IIP Supernova

Principal Investigator: Bostroem, Kyra

PI Institution: University of Washington

Early, ultraviolet (UV) observations of hydrogen rich Type IIP/L core-collapse supernovae (CCSNe) are critical for understanding the connection between massive red supergiant (RSG) stars, their mass loss, and the subsequent SN explosion. During the RSG phase, a significant amount of mass loss occurs, and depending on the duration can surround the star with dense and extended circumstellar material (CSM). When the star eventually explodes as a CCSN, high energy photons from the shock breakout ionizes the CSM. These ionization features can be used to constrain the properties of the CSM, including metallicity density, and structure, mapping the evolution of the final years of life of the progenitor star. UV observations during the first two weeks after explosion are crucial for detecting these high ionization lines, and are the most sensitive to lower densities and weaker CSM interactions which may occur in lower mass RSG progenitors. The dearth of UV (particularly FUV) observations of Type IIP/L SNe at this phase has left many open-ended questions about the role CSM interaction plays in "normal" Type II SNe, and a disruptive ToO with HST in the UV is crucial to obtaining these important data on a very short timescale.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17133
Program Title: Mapping the morphology of the ionizing radiation from a LyC emitting galaxy at z=4.00

Principal Investigator: Mestric, Uros

PI Institution: INAF-Osservatorio di Astrofisica e Scienza dello Spazio

We propose multi-band WFC3 imaging of the ionizing radiation and non-ionizing continuum (F390W, F814W, and F140W) from the most distant and strongest Lyman continuum (LyC) emitting galaxy at z=4, dubbed Ion3. Available VLT/FORS2 and X-Shooter spectra reveal a strong LyC emission from 912 Ang down to 750 Ang, as well as a multiple-peaked Lya profile. Unfortunately, no information on the sub-kpc morphology of Ion3 exist at any wavelengths. This information is vital to constrain the detailed mechanisms that regulate the emission of LyC radiation from star-forming galaxies, especially at 3<z<4, the highest redshift likely to yield direct observations of LyC and the closest to the Epoch of Reionization. With this program we will map the morphology and extent of the LyC and non-ionizing radiation (NUV and FUV) that emerge from Ion3. The HST imaging is essential to (1) investigate the size and light profile of the LyC emission, locate its centroid and study if it is co-spatial or off-centered with respect to the FUV and NUV emission; (2) measure the Balmer break, providing us with age estimates and insight into underlying old stellar population. The HST multi-band imaging will enable us to understand the physical properties of Ion3 and to compare it with those from other detected LyC emitters at high and lower redshift. This will provide the unique opportunity to unveil the mechanisms that regulate the escape of ionizing photons from the LyC galaxy that is the closest in time to those at the EoR.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17134
Program Title: Testing the Limits of Mass Transfer Stability With A Post-Mass-Transfer Binary In M67

Principal Investigator: Leiner, Emily

PI Institution: Northwestern University

Many important systems result from mass transfer (MT) in low-mass binaries including double white dwarf (WD) binaries and Type Ia supernovae. A key uncertainty in modeling these systems is whether the MT will be unstable, resulting in a common envelope that dramatically shrinks the binary orbit. In particular, theory suggests that most MT from an RGB donor should be unstable, but observations reveal many systems that challenge this hypothesis. Here we target WOCS 14020, a main sequence-WD binary in open cluster M67. The orbital period of 359 days suggests the system evolved through stable MT from an RGB donor star. WOCS 14020 is uniquely poised to test the limits of MT stability; the primary main-sequence star is one of the lowest mass outcomes of MT in the cluster, and canonical MT models predict MT on to lower mass accretors to be increasingly unstable. We request 10 orbits of COS FUV spectroscopy to measure the WD mass and cooling age in this system, which together define the evolutionary state of the donor star during MT. Further, WOCS 14020's membership in M67 provides many important constraints that are not usually available in modeling post-MT binaries. Together, this will allow us to construct an unusually detailed evolutionary history for WOCS 14020, and explore whether non-conservative mass transfer models yield stable MT evolution and reproduce the observed system. The results will be an important test of whether non-conservative MT models can empirically match the extent of the post-MT population of a benchmark open cluster. The precise WD mass and age measurements required are only possible with FUV spectroscopy, a capability unique to HST.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17135
Program Title: Imaging interior to 0.2 arcsec with the STIS coronagraph

Principal Investigator: Ren, Bin

PI Institution: California Institute of Technology

Depending on the physical sizes of the coronagraphic occulters on STIS, they have imaged the surrounding environments of central bright sources down to ~0.2 arcsec. Recent understanding of the current ~7 mas pointing stability of HST can push beyond such a limit: by incrementally dithering along the perpendicular direction of the STIS occulters, and with carefully designed exposure times, we could image the surroundings of central sources down to 0.1 arcsec or less. We propose to perferm such an instrumental calbiration exploration for the BAR5 and WedgeA0.6 occulters of STIS, and thus push the supported inner working angle (IWA) to one that supercedes the stated values. Using a total of 4 orbits on the prototypical debris ring around HR 4796A and its point spread function star, we expect to recover the minor axis of the ring at a radius of ~0.15 arcsec. Upon the completion of this program, we will provide STIS instrumental science report to establish formal guidelines in using this mode for future users.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17136
Program Title: Photometry of a Young Planetary-Mass Companion to a Taurus M Dwarf Star

Principal Investigator: Gaidos, Eric

PI Institution: University of Hawaii

Studies of directly imaged planets extend exoplanet surveys to greater separations from the stars, test giant planet formation models, probe the composition of the progenitor disks and can reveal circumplanetary disks, but these objects are rare. We report a faint, co-moving companion to an M dwarf member of the Taurus star-forming region with a brightness and color consistent with super-Jupiter mass planet. This companion is one of the youngest, least massive planets that has been directly imaged. While the object is readily detected in K-band (2.2 microns) AO imaging, key observations at shorter wavelengths are marginal or infeasible from the ground and the host star is too faint for ``extreme'' high-order AO systems. We propose imaging of this object with HST and WFC3 to (1) determine the spectral energy distribution of 2M0437b and compare it to model atmospheres to determine the companion's temperature, luminosity, radius and, via evolutionary models, estimate its mass; (2) constrain the cloudiness and metallicity of the atmosphere via detailed modeling of atmospheric radiative transfer; and (3) search for evidence for an accreting circumplanetary disk in the form of H-alpha or excess UV emission. Multi-planet systems have been found around other young stars and our imaging could also reveal additional, fainter companions of the star at smaller separations.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17137
Program Title: Rise of the Titans: Stellar Properties of a Binary Hyper-Luminous Starburst Within the First Billion Years

Principal Investigator: Riechers, Dominik

PI Institution: Universitat zu Koln

We propose HST/WFC3-IR and ACS observations in 4 bands to characterize the nature and the environment of HeLMS-54, the most distant binary hyper-luminous starburst known, at a redshift of 5.9. This rare, gas-rich (Mgas>2x10^11Msun), dusty starburst (SFR~2900Msun/yr) system was recently discovered with ALMA, NOEMA, and Herschel. It consists of two merging galaxies ~1-2kpc in diameter with dynamical masses of >10^11Msun each, separated by only 19kpc, resolved in dust emission by ALMA at 0.15" (1kpc) resolution. We here request imaging of the rest-frame ultraviolet light at matching resolution to measure the unobscured star formation rate, stellar mass and star formation history of this system through a complete SED analysis, as well as the morphology and sizes of the stellar disks and the UV extinction profile. We will also use the multi-band data to search for dropout galaxies in its environment on Mpc scales using the Lyman-break technique, which will put constraints on its formation history and the dark matter halo mass scale. This investigation could reveal the presence of a massive proto-cluster of galaxies within the first billion years of the Big Bang. Finally, the HST imaging will unambiguously address the possibility of a weak gravitational magnification of this system. Given its extreme cosmic rarity, this is key to properly place the existence and evolution of HeLMS-54 into context with cosmological simulations and models of starburst galaxies at different epochs. This study will be an important pathfinder for detailed investigations of the most exceptional star-forming environments in the early universe with JWST.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17138
Program Title: Studying ionizing photon escape from a bright gravitationally lensed reionization era analog at z=1.43

Principal Investigator: Mainali, Ramesh

PI Institution: NASA Goddard Space Flight Center

We propose WFC3 UVIS/G280 grism observations of a bright lensed galaxy at z=1.43 to measure ionizing (LyC) photons escaping from the system. The combination of unique brightness (g=20.7) and lensing magnification allows measurement of ionizing photon escape at sub-kpc level. The existing ground-based spectroscopy shows spectral features similar to a reionization-era galaxies. Furthermore, the galaxy shows tell-tale signs of ionizing photon production and escape. Based on the newly developed indirect measure of LyC photons using Mg II emission lines, we estimate ionizing photons escape fraction (dust corrected) of 36+/-11%. Our proposed observations will help understand (i) the connection between Mg II emission and LyC photons, (ii) the effects of stellar feedback on LyC photon escape, and (iii) allow spatially resolved Lyman-alpha map in a reionization era analog. This source is one of three at any redshift where a spatially resolved study of LyC photons is possible. This study will add to the extremely rare class of bright lensed systems showing LyC leakage, which will provide further insight to the LyC escape. Our observations will exploit the ultraviolet capability of HST allowing the study of production and escape of ionizing photons from an exceptionally bright z=1.43 galaxy that is representative of reionization epoch.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17139
Program Title: A Fomalhaut deep field to test the dust cloud paradigm of Fomalhaut b

Principal Investigator: Kalas, Paul

PI Institution: University of California - Berkeley

Fomalhaut b has always been a puzzling extrasolar planet candidate because it is bright in the optical and faint in the infrared. Two key hypotheses about its true nature are debated in the literature. If the detected light is reflected from dust, are these grains in a long-lived ring bound to a planet, or is the dust from a transient cloud produced by a catastrophic collision between two planetesimals caught at exactly the right time? The first four epochs of HST astrometry up to 2012 revealed a highly eccentric orbit. However, the next epoch in 2013 with STIS showed evidence for a shift to non-Keplerian radial motion that could indicate the radiation pressure blowout of small, unbound grains. If Fomalhaut b is a transient cloud, it should also become spatially extended and fade over time. However, different investigators analyzing the same HST data disagree on whether or not it is variable and extended. The root of the problem is that each HST/STIS epoch of observation was planned for a low SNR detection that was sufficient to track its orbit, but not for extracting precision photometry and measuring spatial extent. Here we propose to solve this problem by obtaining the deepest HST/STIS coronagraphy to date. These data will robustly ascertain Fomalhaut b's brightness, morphology, and location in 2022 and conclusively test the validity of the dust cloud paradigm. The data will also have significant legacy value for the many observers and theorists studying the system. Fomalhaut is a key JWST GTO target and determining Fomalhaut b's properties in 2022 with HST will serve a crucial role for interpreting the results of the upcoming deepest-ever infrared observations.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17140
Program Title: Toward an observational test of the Lambda CDM hierarchical paradigm at the smallest galaxy scales

Principal Investigator: Annibali, Francesca

PI Institution: INAF-OAS Bologna

Deep, wide-field ground-based imaging has led to the discovery of low-surface brightness tidal features around three small dwarf galaxies (with stellar masses between 10^7 and 10^8 Msun) at distances between 3 and 4 Mpc: UGC 8760, UGC 6541, and NGC 5238. The three galaxies are isolated, without any identifiable companion that could cause the observed tidal disturbances. Of 45 dwarf galaxies imaged to comparable depth, they are the only strong candidates of dwarfs in the process of accreting smaller satellites, thus a signature of hierarchical structure assembly on the smallest scales. Remarkably, direct evidence of satellite accretion has so far been observed in dwarfs typically more massive than these. Preliminary N-body hydrodynamical simulations suggest that the merger events occurred no longer than ~1 Gyr ago. To confirm this hypothesis, we propose new deep ACS imaging in V and I that will enable the characterization of the stellar populations of the host dwarfs and of their satellites' remnants, and to infer their detailed star formation history (SFH) over the last ~1 Gyr. Analysis of these new data will potentially reveal the presence of starbursts triggered by pericenter passages during the interaction. Together with the galaxy kinematical properties, the SFHs will provide a crucial ingredient for N-body hydrodynamical simulations aimed at reconstructing the properties of the dwarf progenitors and their merging history. Ultimately, these results will be compared with cosmological simulations that predict the satellite population around dwarf galaxies of different masses, providing a first test of the Lambda CDM hierarchical paradigm at the smallest galaxy scales.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17141
Program Title: Probing Multiple Formation Below 1Msun: Towards the Opacity-Limit for Fragmentation from 7.5-150 au in NGC 1333

Principal Investigator: De Furio, Matthew

PI Institution: University of Michigan

Multiplicity studies of the Galactic field have revealed important trends in companion frequency, mass ratio, and separation as a function of primary mass, from O-stars to T-dwarfs. Importantly, similar studies in young, star-forming regions have identified an excess of companions to low-mass stars relative to the field in low-density regions, but find a comparable frequency of companions to low-mass stars relative to the field in high-density regions. We propose a small, seven-orbit program with ACS/WFC in parallel with WFC3/UVIS to obtain multi-filter photometry of NGC 1333 (a nearby intermediate density cluster) to perform a multiplicity suvery, characterizing the companion population for primary masses 0.01-1.0 Msun and search for trends based on primary mass and stellar density. Using the empirical PSFs previously derived across the detector for each filter/instrument combination, we will search for close companions with a PSF-fitting technique, proven to detect companions down to 0.5 pixels (0.025") on ACS/WFC, corresponding to 7.5 AU at 300 pc. With the 150 confirmed cluster members within our field of view, we expect to detect 33 companions (if the companion population of NGC 1333 resembles the field) which allows us to place constraints on its mass ratio distribution as a function of primary mass and separation, exploring star formation processes and cluster dynamics in creating and shaping these multiple systems.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17142
Program Title: Europa's UV absorptions: oceanic or exogenic origins?

Principal Investigator: Trumbo, Samantha

PI Institution: Cornell University

Recently resurfaced terrain on Europa may contain compositional fingerprints of the internal ocean, providing a window into its chemistry and habitability. However, understanding the relationship between the surface and subsurface chemistries relies on distinguishing endogenic species from those produced via the exogenic bombardment of the surface with Jovian magnetospheric particles. Over the past 20+ years, numerous studies have sought to disentangle the two, but have been stymied by either a lack of spectral features across the wavelengths explored, a lack of sufficient spatial resolution to discern geology from background magnetospheric patterns, or both. High-spatial-resolution observations in the mid-UV would provide a singular opportunity to build our understanding of these contributions to Europa's surface, which will soon be visited by two Flagship-class spacecraft missions--NASA's Europa Clipper and ESA's JUICE. Two of Europa's fewer than ten compositionally diagnostic absorption features (other than those of water ice) lie at mid-UV wavelengths, including the only feature indicative of the plausibly endogenic SO2 and a feature newly discovered this year that could indicate endogenic salt or an exogenic radiolytic product. We propose a simple slit-scanning program with STIS in G230L to map these features at the high spatial resolution necessary to determine their origins. As neither spacecraft mission carries instrumentation spanning these wavelengths, HST provides the only opportunity to map Europa across this critical wavelength range, thereby enhancing the scientific return of the upcoming missions.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17143
Program Title: Identification of dual quasars with close separations at z>1

Principal Investigator: Ding, Xuheng

PI Institution: Institute for Physics and Mathematics of the Universe

We propose to use HST/WFC3 in slitless grism mode to spectroscopically confirm the nature of eleven dual quasar candidates with projected separation between 0.35"-0.7" (corresponding to a projected separation of 3-6 kpc), an extremely rare population (11 out of 59,025 quasars from a search area of 500 square degrees). With the exquisite wide and deep imaging from the Hyper Suprime-Cam Subaru Strategic Program, we have identified a population of 386 SDSS quasars as having two bright and separate components that are candidates for dual supermassive black holes, many of which are within the same host galaxy, likely the result of a major merger. For eleven candidates that have the closest separation at z>1, HST is needed to spectroscopically confirm their nature and their redshift by detection of broad emission lines from both objects. The high sensitivity of HST would further help us to rule out the possibility of lensing. Any confirmed physical quasar pair from our candidates would be the first case ever confirmed that has a projected separation below 6 kpc beyond z>1. This sample will be the key to understanding the merger process and how it affects galaxy evolution and AGN activity, since they are at close to final coalescence stage. Furthermore, this program will provide remarkable laboratories for studying the fueling of dual supermassive black holes with ALMA study. Moreover, taken together with the wider separation dual quasars confirmed by ground-based observations, we will measure the dual quasar fraction and its evolution up to z~3. The results will be compared with the predictions from recent hydrodynamic cosmological simulations.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17144
Program Title: Confirming the Formation of Black Holes

Principal Investigator: Kochanek, Chris

PI Institution: The Ohio State University

There are good observational and theoretical reasons to believe that 10-30% of the core-collapses of massive stars lead to the formation of black holes without a supernova explosion. A survey using the Large Binocular Telescope has identified one good candidate in NGC6946 and new candidate in M101. In N6946, a roughly 300,000 Lsun star vanished in the optical to leave a fading, few 1000 Lsun near-IR (HST F110W/F160W in 2015/2017) source. It is very difficult to reconcile the evolution with a dust enshrouded, but surviving, star. A new epoch of HST near-IR observations to confirm the continued fading will greatly strengthen this argument. The new candidate needs to be characterized to establish a baseline from which to evaluate its future evolution and status. Because of the low fluxes and crowding, good photometry can no longer be obtained from the ground.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17145
Program Title: Clearing a Window Into Galaxy Formation: The Impact of Globular Cluster Metallicity Distributions

Principal Investigator: Harris, William

PI Institution: McMaster University

The MAST archive holds a rich legacy of imaging data for globular cluster (GC) systems in external galaxies that represents an investment of hundreds of HST orbits. But its full impact to make GCs key tracers of galaxy formation has yet to be realized. To achieve that, their true metallicity distribution functions (MDFs) must be established on an internally consistent base. Such MDF parameters as the mean metallicity, and the relative numbers of `blue' (metal-poor) and `red' (metal-rich) GCs are key predictions from current galaxy and GC formation theories that help decode the history of accretions versus in-situ formation. The observational barrier is that direct spectroscopic metallicities for GCs are hard to obtain in large numbers and are beyond reach for very distant galaxies. In most cases we have to work instead with the GC color distribution function (CDF), the photometric proxy for the MDF. But the many optical/NIR color indices that have been used to generate CDFs are all nonlinear functions of metallicity and give biased, misleading impressions of the true MDFs. We propose an efficient program of multifilter imaging of the Coma BCG NGC 4874, the richest GC system in the local universe, to measure all the commonly used GC color indices in a single system. Direct empirical transformations will be derived for every color into the fiducial index (g-z), which is the only one with a well established conversion into [Fe/H] based directly on spectroscopic metallicities. This program will take a major step towards defining the true MDFs for GC systems in almost 200 galaxies, and a new level of comparison with theory.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17146
Program Title: A High-Definition View of the Baryon Cycle in Massive Galaxies

Principal Investigator: Zahedy, Fakhri

PI Institution: Carnegie Institution of Washington

Multiply lensed QSOs provide a powerful means to spatially and spectrally resolve gas flows in galaxies and answer outstanding questions on the baryon cycle and its impact on galaxy evolution. They probe multiple locations in the inner regions (d<10 kpc) of the massive lensing galaxies, unveiling the complex properties of diffuse gas from interstellar to circumgalatic space. While most massive galaxies are quiescent, recent studies reveal that they can harbor significant cool (T~1E4 K) gas in their halos. Such findings challenge the notion that their lack of star formation is caused by an absence of gas, and imply that complex feedback/environmental processes are at play. We have identified a sample of 8 massive (M_star>1E11 M_sun) lens galaxies at z=0.3-0.8, with 16 lensed QSO images suitable for UV spectroscopy (two per galaxy) situated at d<10 kpc. Two lensed QSOs have UV spectra available in the HST archive. We propose new STIS/UV spectroscopy with the G140L/G230L gratings for the remaining six QSOs. The wide spectral coverage enables detection of the full HI Lyman series, necessary to probe the bulk of the gas content, and various ionic metals tracing multiple gas ionization states. The main objectives are to (1) map N(HI) and its spatial variations on <10 kpc scales, (2) constrain the multiphase gas properties and explore their implications for feedback, and (3) characterize the chemical abundances and resolve the physical origin of the gas (aided by high-resolution spectra from the ground). Our program will provide critical insights into massive galaxy evolution and quadruple the number of massive galaxies at z>0 with spatially resolved multiphase gas properties.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17147
Program Title: The Parallel Ionizing Emissivity Survey

Principal Investigator: Scarlata, Claudia

PI Institution: University of Minnesota - Twin Cities

The Parallel Ionizing Emissivity (PIE) Survey will measure the average escape fraction of ionizing radiation (f_esc) at 3.1<z<3.5 using a sample of ~700 galaxies. Using 3-band imaging (F336W, F625W, and F814W), PIE will color-select U-dropout galaxies, where LyC is sampled by the F336W band. Pure parallel orbits will enable us to observe a total area of ~500 arcmin^2 divided over ~75 truly independent fields distributed across the extragalactic sky. This sampling will minimize the effect of IGM absorption (correlated on scales of 10s of Mpc) on the measurement of f_esc. Likewise, our proposed high spatial resolution HST imaging will avoid contamination by low-redshift galaxies. In addition to the HST imaging, we are requesting 10 nights of coordinated observations with NOIRLab Gemini telescopes (in addition to guaranteed institutional access to 8-m class telescopes) to measure the spectroscopic redshifts of the LyC emitting candidates that we will identify. The proposed data, combined with the spectroscopic followup of the selected Lyman break galaxies, will allow us to measure escape fractions of 10% at 3-sigma by stacking ~150 targets as faint as 0.4L*. We will calibrate the evolution of f_esc indicators out to z~3.5--measuring f_esc as a function of star formation surface density, Ly-alpha properties, UV luminosity, and UV colors. The proposed dataset will be a resource for the astronomical community for the foreseeable future, more than doubling the existing area with deep HST U-band coverage, and greatly increasing the number of sight-lines.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17148
Program Title: Preparing to find the sources of the reionization: Testing MgII as a Lyman Continuum tracer using a unique mock JWST sample

Principal Investigator: Leclercq, Floriane

PI Institution: University of Texas at Austin

Understanding how galaxies contributed to reionize the universe is one of the principal science goals of the James Webb space telescope (JWST). Because the IGM is neutral at high-redshift, and therefore optically thick to ionizing radiation (LyC), JWST needs indirect LyC diagnostics calibrated on low redshift sources to unveil the sources of reionization. Here we propose the first sample selected based off their Mg II emission properties to have predicted LyC escape fractions. These 35 orbits of COS/HST observations will stringently test the best current LyC escape tracer in exactly the conditions that JWST will use it to infer the sources of cosmic reionization. Our mock JWST sample is completely different than any LyC sample as it is selected to have low neutral gas column densities. By comparing the Lyman Alpha and Mg II profiles we will understand the conditions when Mg II is optically thin and inform when JWST observations can use Mg II to measure the LyC escape fraction. The diverse physical properties of our sample and predicted LyC escape fraction will enable us to constrain the impact of dust and gas-phase metallicity in the inferred LyC properties. Two proposed targets are predicted to be extremely rare strong LyC emitters, while being normal star forming galaxies. If confirmed, these objects will provide a novel window into the escape of LyC. Beyond a simple test of confirmation, we will treat these observations as if they were up-coming JWST observations to demonstrate whether future JWST observations can recover the LyC escape fraction.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17149
Program Title: Characterizing the unusual star cluster population in a candidate dark matter free galaxy

Principal Investigator: Romanowsky, Aaron

PI Institution: San Jose State University

We propose to characterize the star cluster population of the Fornax cluster low-surface brightness dwarf galaxy FCC 224. Current data suggest that the clusters are over-luminous relative to a standard globular cluster luminosity function (GCLF) -- missing the bulk of the expected clusters at faint magnitudes. This top-heavy LF has been seen previously in two old, dark matter free galaxies, NGC 1052-DF2 and -DF4, and is understood to be closely connected to the formation of these galaxies without dark matter. FCC 224 may therefore be only the third known example of this puzzling class of galaxies, and the first in a different environment from the NGC 1052 group. We will test definitively the resemblance of this galaxy's cluster population to those of DF2/DF4, where the clusters also have unusually large sizes and are further accompanied by a smaller population of "normal" clusters with a GCLF peak at the standard luminosity. Confirming these peculiarities in FCC 224 would complement deeper spectroscopic follow-up to test for the presence of dark matter, would potentially pave the way for using GCLF photometry to efficiently identify more dark-matter-free galaxy candidates, and would provide additional leverage on understanding star cluster formation in general.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17150
Program Title: Targeted Observations of Ceres' Occator Crater with HST/STIS

Principal Investigator: Trumbo, Samantha

PI Institution: Cornell University

We propose targeted single-orbit STIS observations of Ceres' Occator crater in order to unambiguously confirm or reject the possible identification of sodium chloride color centers in Dawn visible-channel spectra of Occator's bright spots Cerealia and Vinalia Faculae. The Dawn visible channel was affected by perplexing artifacts resulting in anomalous spectral shapes that required improvised, empirical calibration steps, and the published visible-channel spectra of Cerealia Facula across different image cubes and reasonable reduction methods appear to disagree. Though some exhibit features potentially consistent with sodium chloride, others show a complete lack of visible spectral features altogether. As abundant sodium chloride is expected for faculae formation mechanisms involving a relict ocean brine reservoir, resolving this ambiguity would be an important step toward understanding not just the formation and evolution of Ceres' enigmatic bright spots, but also its potential status as a relict ocean world.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17151
Program Title: Massive star clusters in low star formation regime dwarfs?

Principal Investigator: Messa, Matteo

PI Institution: University of Geneva, Department of Astronomy

We propose to determine whether the high end of the star clusters mass function is truncated in low density dwarf galaxies. We will image the cluster populations of 10 nearby dwarfs, aiming at collecting a statistically significant sample of clusters, about 150 across all galaxies, in order to overcome current uncertainties driven by low-number statistics. The proposed 5 bands (NUV-U-B-V-I) observations leverage the UV and high angular resolution capabilities of HST to accurately measure the physical parameters (age, mass, extinction) of the star clusters. We will be able to establish whether and how star formation depends on the local or global galaxy environment, and how much of the star formation in dwarfs takes places in bound clusters, therefore testing whether low-density dwarf galaxies are scaled-down versions of spirals or are instead simply less efficient at forming bound structures. The cumulative star cluster population will provide enough statistics to measure the upper mass truncation with an accuracy of better than 0.5 dex or to robustly rule out its presence, enabling us to determine whether the dearth of observed massive clusters in dwarfs is driven by stochastic sampling at the high mass end (a direct consequence of their low SFRs) or by inhibiting mechanisms driven by physical properties (e.g. the low-density environment in dwarfs). Young massive clusters can be significant sources of ionizing and mechanical energy. Determining the environmental conditions that favor the formation of massive clusters could help isolate the sources of reionization of the early Universe, one of the key science goals of the just-launched JWST.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17152
Program Title: Probing for the extended exosphere of a 100 Myr mini-Neptune

Principal Investigator: Zhou, George

PI Institution: University of Southern Queensland

Photoevaporation shapes the Neptunes and super-Earths that we find in abundance around Sun-like stars. We will use STIS to probe for the escaping hydrogen exosphere of a mini-Neptune that is undergoing run-away mass-loss. HIP 94235b is a newly discovered planet around a 100 Myr old X-ray active Sun-like star in the AB Doradus moving group. It lies on the edge of the sub-Neptune desert that is thought to be sculpted by early photoevaporation. Unlike previous planets surveyed by HST with detected Lyman alpha escaping atmospheres, HIP 94235b is younger than its run-away mass-loss timescale, and is in the process of shedding the majority of its primordial hydrogen helium envelope. We will observe three Lyman alpha transits of HIP 94235b with STIS, and search for signatures of a significant neutral hydrogen exopshere. We expect transits with >10% transits to be detectable at high significance despite the stellar activity expected for such young stars. Comparing the true mass-loss rate against the energy-limited estimates will help us better understand the factors that govern the early evaporation history of young Neptunes. The extreme XUV environment HIP 94235b resides in will also help guide models of interactions between the stellar wind and escaping hydrogen atmospheres, crucial in interpreting all Lyman alpha transit results from past HST observations.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17153
Program Title: Resolving Lyman Alpha emission in a complete sample of Lyman Continuum leakers and non-leakers

Principal Investigator: Leclercq, Floriane

PI Institution: University of Texas at Austin

Determining the contribution of galaxies to cosmic reionization is one of the most pressing challenges of modern observational cosmology. Because the IGM is optically thick to ionizing radiation (LyC) during the epoch of reionization, indirect LyC escape probes are needed. Recent reionization studies have used indirect LyC tracers calibrated on samples that do not fully represent the diversity of the LyC emitters population. Here we propose 49 orbits of HST-COS observations to obtain high resolution spectra of the most promising LyC tracer, the Lyman Alpha (Lya) emission, for 15 galaxies with rigorous LyC constrains selected from the new Low-Redshift Lyman Continuum Survey (LzLCS). Our targets will complete an existing archival sample of 31 galaxies, sampling the full range of possible high redshift LyC escape fractions. By assessing whether the Lya profiles of non/weak LyC leakers are observationally distinguishable from those of moderate leakers, our observations will test if Lya can distinguish between galaxies that could and could not have reionized the universe. The large LyC escape fraction dynamical range of our complete sample of LyC leakers and nonleakers will investigate if the large scatter observed between the Lya profile and escape fractions in the archival sample can be explained by a spread in other physical parameters. This proposal will also validate other indirect tracers by comparing the Lya and Mg II profiles with radiative transfer models. Our observations will establish a definitive sample of indirect LyC probes that the James Webb Space Telescope urgently needs to unveil the sources of cosmic reionization.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17154
Program Title: ACS Observations in a JWST CVZ Field --- providing the missing link for a JWST time-domain science initiative

Principal Investigator: Yan, Haojing

PI Institution: University of Missouri - Columbia

We propose ACS F435W, F606W, and F814W imaging in the IRAC Dark Field (IDF), which is in the JWST continuous viewing zone (CVZ) and will be observed by JWST GTO program #1176 in three epochs in Cycle 1 using NIRCam. The 3-epoch JWST data (>28.5 mag) will enable time-domain science such as finding and studying core-collapse supernovae in dusty starbursts and high-z Type Ia supernovae potentially to z=6. Reaching the full scientific potential, however, requires high-resolution data in the optical bands that are either not accessible to or not optimized with JWST. Our program will take advantage of the overlap in mission life of HST and JWST to fill in this crucial gap. To maximize the return, the proposed ACS observations will be split into two epochs that are contemporaneous with the 2nd and 3rd epochs of the JWST GTO observations, respectively. (The JWST schedule will be announced in April.) The contemporaneous ACS observations will enable a joint analysis of the time-domain events found in the NIRCam data. The complementary ACS data will be critical because any time-dependent evolution should be removed from the SEDs for a proper analysis. With these data, we will be able to -- identify and study the exact sites (within the host galaxies) associated with the events, -- estimate the dust extinction corrections appropriate for the events, and -- constrain the source redshifts when the association with the host galaxy is unclear or when the host galaxy is too faint for spectroscopy. In addtion, the combined, "static" ACS images will enable a slew of extragalactic studies that require a fair wavelength sampling from optical to near-IR (e.g., z>10 dropout searches).

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17155
Program Title: The legacy UV survey of 28 pulsars

Principal Investigator: Kargaltsev, Oleg

PI Institution: George Washington University

Previous HST explorations of neutron stars have led to a plethora of discoveries and new puzzles, including hotter-than-expected old pulsars, enigmatic optical-UV excess for some objects, potential disks, and a new type of pulsar wind nebulae. The scarcity of objects targeted with HST and the diversity of their observed properties, even for seemingly similar pulsars, make it currently impossible to arrive at a comprehensive view and an unambiguous interpretation of the optical-UV properties of neutron stars. A significantly enlarged sample of pulsars observed in optical-UV (with flux measurements or deep upper limits) is desperately needed in order to tackle the many open questions. For this reason, we propose a survey of a large sample of neutron stars in the far-UV. Only HST can carry out this legacy UV-survey which is needed to select targets for future studies in the optical and infrared. The UV observations of middle-aged and old neutron stars are required to constrain the fundamental physics of these compact objects. We expect that the collected HST data will be used by observers and theoreticians alike for years to come.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17156
Program Title: Transiting Ultra-hot Gas Giants: Astrophysical Laboratories for Atmospheric Escape Studies

Principal Investigator: Cauley, Paul

PI Institution: University of Colorado at Boulder

Transit surveys employing small telescopes have revealed a population of ultra-hot gas giant planets (T_eff > 2000 K, R_p > R_Jup) orbiting early-type stars, worlds unlike anything in our solar system. Many of these planets orbit hot host stars (A-type) with very short periods (P_orb < 5 days), experiencing large radiative heating rates. These ultra-hot planets are the most far-ultraviolet (FUV)-irradiated systems known. However, their extreme-ultraviolet (EUV) irradiation, which drives mass loss from traditional hot Jupiters, is likely quite low. We propose an FUV transit spectroscopy experiment to study four planets straddling the ``EUV divide'' to quantify the transition from EUV-driven to FUV-driven escape. We will use these data to measure the dependence of atmospheric ionization and mass loss rate on the relative strengths of the stellar FUV and EUV radiation fields. A-stars emit strong photospheric flux at FUV wavelengths, providing a backlight against which a myriad of outflowing species can be observed. Our FUV spectroscopic program will measure transit depths in never-before-detected low-ionization, neutral, and molecular species believed to be rapidly escaping from the atmosphere of these planets (e.g., S I, Si II, C I, N I, Al II, and possibly CO and He II). These observations will provide mass loss and atmospheric ionization measurements of planets orbiting A-type stars to test the importance of the FUV/EUV radiation environment and characterize atmospheric escape in its most extreme forms.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17157
Program Title: Observing the Overlooked Double Lyman-alpha Transit of HD 189733 b to Break Mass Loss Rate Degeneracies

Principal Investigator: Loyd, R. O.

PI Institution: Eureka Scientific Inc.

Lyman-alpha transits provide a window into atmospheric escape, a process that has observably shaped the exoplanet population. However, mass loss estimates from these observations are highly model dependent. A recently predicted feature of hot Jupiter transits could begin dismantling this model dependence: the delayed transit of the outflow tail. These transits have been hiding in plain sight, just slightly beyond the primary transits sampled by past Lyman-alpha transit observations. Critically, the plasma causing this delayed transit will have reached ionization equilibrium. Knowing the plasma's ionization state eliminates a confounding factor from the interpretation of the transit signal, enabling a stronger link between the the observations and the rate and efficiency of the planet's mass loss. This program will observe the delayed transit from the outflow tail of HD 189733 b, a planet with a well-established primary Lyman-alpha transit. The outcome will be an improved measurement of HD 189733 b's mass loss rate and efficiency, with broader implications for mass loss across the population of exoplanets.

Proposal Category: SNAP
Scientific Category: Galaxies
ID: 17158
Program Title: The lowest luminosity galaxy candidates ever discovered outside of the Milky Way

Principal Investigator: Bell, Eric

PI Institution: University of Michigan

Faint dwarf galaxies are the observational bedrock of small-scale cosmology and galaxy formation. The faintest of these, the ultra-faint satellites of the Milky Way, are particularly informative: as they have formed so few stars, they are very sensitive to the details of dark matter properties, feedback and reionization. While many models have been tuned to reproduce the Milky Way's satellite population well, large variations between the luminosity functions of bright dwarfs in nearby groups coupled with theoretical expectations for variations in ultra-faint populations motivate searches for ultra-faint dwarfs in other groups. Recent advances in wide-field deep multi-band imaging, star-galaxy separation and dwarf candidate search techniques place us in a position to explore this issue on a statistical footing. Sufficient data exists in five nearby galaxy groups: M31, M81, M64, M83 and M94. We have identified 55 faint and ultra-faint satellite candidates using criteria designed to be as selective and restrictive as possible, while recovering artificial galaxies 3-10x deeper than current limits in these groups. We request 55 SNAPs with ACS and WFC3 in parallel (for local 'background' estimation and legacy stellar halo science) to confirm a subset of this statistical sample. This program will confirm the faintest ever galaxy found outside the Milky Way, will allow measurement of their luminosities and sizes, will provide deep enough color-magnitude diagrams to constrain distance, metallicity and young stellar populations, and will propel robust Local Volume ultra-faint galaxy searches on an industrial scale with next-generation facilities like the Vera Rubin Observatory.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17159
Program Title: Escaping Lyman Continuum from the Overdensities of Extreme Emission Line Galaxies at z~2.2

Principal Investigator: Wang, Xin

PI Institution: California Institute of Technology

Collectively young massive stars dominate over supermassive black holes in producing the Lyman-continuum (LyC) radiation that reionized the Universe. Yet the direct measurement of such escaping LyC radiation has been challenging. ~50% of galaxies in the reionization epoch reside in protoclusters, hence the knowledge about LyC escaping from overdense environments is crucial. We propose to obtain deep WFC3/UVIS imaging in two massive protocluster fields at z~2.2, efficiently measuring the absolute LyC escape fraction (fesc) of 28 extreme emission line galaxies (EELGs) in total. These EELGs are identified from the existing deep WFC3/G141 slitless spectroscopy of the entire fields, showing prominent [O III]+Hbeta emission with extremely high equivalent width, perfect analogs of currently known galaxies at z~8. Targeting multiple overdensities helps mitigate the line-of-sight variations of intergalactic medium (IGM) transmission. The goals of this proposal are as follows. 1) Measure fesc of these EELGs residing in overdensities to 3-sigma upper limits of 1.6%(0.5%) per galaxy(sightline), to probe the environmental dependence of fesc. 2) Test whether faint galaxies or rare bright galaxies with high fesc dominate the reionization process, and calibrate the observational proxies of LyC leakage for future JWST work. 3) Break the degeneracy between fesc and the LyC production efficiency to measure the production rate of IGM-ionizing photons, constraining if the ionizing budget from EELGs is sufficient for reionization. Exploiting the unique UV capabilities of HST, our program presents a giant leap forward to establish the link between LyC escape and large-scale structure formation.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 17160
Program Title: New frontiers in gravitational lensing: multiply-imaged supernovae

Principal Investigator: Goobar, Ariel

PI Institution: Stockholm University

Multiply imaged Type Ia supernovae rank among the most exciting transient phenomena. These "standard candles" can be used to locate systems with strong gravitational lensing, independently of image separation. Upon discovery using the Zwicky Transient Facility, we will use ToO follow-up observations with HST to measure the magnification, image positions, time-delays and host galaxy arcs of these systems. From these we can measure the expansion rate of the Universe with ~3% precision. This will shed new light on the tension between the global and local measurements of the Hubble constant. Besides getting optimally sampled lightcurves at optical and NIR wavelengths, we will explore the accuracy of time-delay measurements from spectroscopy, a much faster route, thus potentially a breakthrough in the study of strong lensing in the time-domain.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17161
Program Title: Compact binary mergers: R-process kilonovae and ultra-relativistic jets

Principal Investigator: Tanvir, Nial

PI Institution: University of Leicester

The discovery of a gamma-ray flash and kilonova (KN; aka. macronova), AT2017gfo, associated with the first binary neutron star (BNS) merger detected by aLIGO/AdV, GW170817, heralded the era of GW+EM multi-messenger astronomy. This landmark event confirmed both the association of short GRBs with binary mergers, and that neutron star material can be ejected in sufficient quantities to power a detectable radioactive transient. It opened a new window on several long-standing problems in astrophysics, cosmology and fundamental physics, including the possibility that BNS and NSBH compact binary mergers represent the dominant source of heavy r-process elements in the universe. However, the lack of success in identifying similar events in the O3 run of the gravitational wave detector network highlighted that their rate is low in the nearby universe (e.g. d<200 Mpc), thus opportunities for intensive study of kilonovae, crucial to understanding their heavy element yields, for example, will be infrequent. Here we propose a ToO campaign targeting a kilonova discovered during cycle 30. Apart from those coincident with GW detections, KNe may be found in blind surveys or accompanying low-z (but still beyond GW range) short-GRBs. HST has already made unique contributions to the follow-up of AT2017gfo and its off-axis relativistic jet, and also provided the primary evidence for the most compelling cases of KNe following SGRBs. Our HST+XMM program is flexible to adapt for different possible scenarios, and will be crucial for understanding the diversity of EM emission from neutron star compact binary mergers, and providing the data to test increasingly sophisticated KN models.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17162
Program Title: The HST/JWST synergy: A deep dive into the NUV with WASP-39b to answer key formation questions

Principal Investigator: Sing, David

PI Institution: The Johns Hopkins University

JWST is poised to transform our understanding of exoplanet atmospheres, as exquisite near-IR spectra will soon be obtained providing a detailed look at molecules such as H2O, CO, CH4 and CO2. Because JWST can only observe past 0.6 um, HST will be required to observe at shorter wavelengths into the NUV. Working together, these two powerful observatories can probe a planet's atmosphere all the way from the far UV to the mid-IR. The transit exoplanet community's very first look at JWST data will come from the Early Release Science (ERS) program which is targeting the Saturn-mass planet WASP-39b. This will be the only exoplanet where ALL of JWST's near-infrared instruments will be used on the same target in a manner that enables detailed instrument comparisons, resulting in a legacy high-quality spectrum. WASP-39b is an important gas giant planet as it is still the only one known to show evidence of a very-high metallicity, indicating a differing formation mechanism than other planets. However, there is a startling controversy in the literature regarding the true metallicity, as the current HST/STIS data suffers from calibration offsets and a highly uncertain NUV spectrum. By combining six HST/UVIS transits of WASP-39b, a precision NUV to optical spectrum can be obtained with Hubble that will be comparable in quality to those obtained with JWST. With a new high precision HST and JWST ultra-broadband transmission spectrum, the metallicity controversy can be resolved enabling an accurate insight into its formation history. WASP-39b offers a unique chance to fully probe the synergy between HST and JWST, exploring the true limits of atmospheric characterization.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17163
Program Title: Probing the icy regoliths of Europa with imaging polarimetry

Principal Investigator: Sparks, William

PI Institution: SETI Institute

We propose to obtain high spatial resolution imaging polarimetry of the surface of Europa to localize features in the polarization phase curve which are diagnostic of fresh deposition, sintering and aging, allowing identification of regions of recent cryovolcanism and subsurface activity. We will seek a relationship between polarization and global thermal inertia maps, and between polarization and spectroscopically distinct compositional units. Polarization and thermal inertia probe regolith porosity, surface transparency, composition and topography, while spectroscopically distinct regions relate to absorbing chemical admixtures. The overall global polarization pattern will constrain the systematic ice scattering characteristics. This polarimetric suite of high-resolution HST images, with its unique emphasis on surface physics, will complement the wide variety of upcoming observations from major flagship missions JWST, Europa Clipper, JUICE and Juno as well as thermal ALMA imaging. With Europa and its global saline ocean at the forefront of strategic planning for NASA and ESA as a target of exceptional astrobiological importance, it is essential to advance our understanding of the Europa surface to the maximum.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17164
Program Title: Exploring The Plane of Satellites Around NGC253: A Case Study for Isolated Environments

Principal Investigator: Mutlu-Pakdil, Burcin

PI Institution: University of Chicago

The distribution of dwarf satellite galaxies is a strong test for models of galaxy formation and evolution, independent of the exact details of baryonic physics. The three observed planes of satellites known today (around the Milky Way, M31, and Centaurus A) constitute a main problem for the standard cosmological models, where satellite systems are expected to have a nearly isotropic distribution. As these three systems reside in rich galaxy groups, their specific local environment could be responsible for the observed satellite planes. Exploration of satellite planes in other galaxies, in different environments, is thus a critical first step in solving the 'plane of satellites' problem. A spatially flattened dwarf satellite system has recently been proposed around NGC253 (D=3.5 Mpc), a Milky Way-mass spiral galaxy in an isolated environment. However, four faint dwarf candidates still lack distance measurements, and prevent us to draw a final conclusion on the true nature of this alleged plane of satellites (based on ten confirmed dwarf satellites). We request four orbits of HST/ACS in F606W and F814W to image these four NGC253 dwarf candidates in order to confirm their nature, precisely measure their distances, and study the 3D structure of the NGC253 dwarf satellite system as a whole. The results from this modest request will constrain the proposed plane of satellite galaxies in NGC253, an essential test for cosmological models in isolated environments.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17165
Program Title: Accurate Distances to Canonical Seyferts

Principal Investigator: Bentz, Misty

PI Institution: Georgia State University Research Foundation

We propose to measure the first accurate distances to three canonical Seyfert galaxies using Cepheid variable stars and the Leavitt Law. The three targets -- NGC 1068, NGC 3783, and NGC 4303 -- are a mix of nearby Seyfert 1s and 2s, and each has been heavily studied to understand AGN physics and black hole feeding and feedback. Unfortunately, none of these galaxies has a distance that is currently known to better than a factor of a few, and they are near enough that they cannot be assumed to be securely in the Hubble Flow. All three targets have direct black hole mass measurements that require accurate distances. Accurate distances are also a critical piece of information for thousands of other published studies that span the electromagnetic spectrum and focus on these galaxies. Only Cepheids are capable of determining distances accurate to 2-3% for late-type active galaxies at D = 15-40 Mpc such as these, including galaxies that are viewed face on (NGC3783) or that may be associated with large groups or clusters (NGC4303) and for which other methods are inaccurate. Only during the remaining limited lifetime of HST will we be able to detect and characterize Cepheids in these canonical Seyferts, providing the first accurate distance to each one and removing a critical and often overlooked source of uncertainty.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17166
Program Title: Fission of Transuranic Nuclei: A Potential Observational Signature in Metal-Poor Stars

Principal Investigator: Roederer, Ian

PI Institution: University of Michigan

This proposal aims to detect fission fragments among cadmium (Cd, element 48) abundances in stars. Transuranic elements are produced during rapid (r) neutron-capture nucleosynthesis, and models predict that many of these nuclei will fission into lighter ones listed near the middle of the periodic table. Fission models rely heavily on uncertain theoretical extrapolations from stable nuclei, which cannot be verified by current experimental techniques. Astronomical observations, on the other hand, provide a novel opportunity to constrain these models. New STIS E230H spectra (R = 114,000, S/N = 15 to 25, covering 2024-2301 A) of two well-studied UV-bright metal-poor r-process-enhanced stars will be collected. Abundances of Cd and tellurium (Te, element 52, which is not expected to show fission signatures and will be used as a control) will be derived to a precision of approximately 0.10-0.15 dex. The abundances will be compared with Cd and Te signatures previously derived for stars without high r-process enhancement, resulting in a 50% improvement in the mean abundance uncertainties. These measurements will demonstrate whether or not there are statistically significant signatures of fission fragments among the Cd and Te abundances. This new, interdisciplinary approach linking observational astronomy and theoretical nuclear physics will provide the first meaningful constraints on the fission fragment distribution for nuclei with atomic masses from 111 <= A <= 116 and 125 <= A <= 130. These spectra will also enable the detection of more than 25 other elements in each star and provide high-quality archival data for future studies of other stellar phenomena.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17167
Program Title: Multiplicity among free-floating planets

Principal Investigator: Bouy, Herve

PI Institution: Universite de Bordeaux

We propose to use WFC3/UVIS to study the multiplicity of a sample of 60 young free-floating planets recently identified in the nearby Upper Scoand Taurus associations. The formation of these exotic objects is still largely an open question. Have they been ejected or stripped away from the planetary system in which they were born? Or did they form isolated in a similar way to stars from the collapse and contraction of a tiny molecular clump? WFC3/UVIS unique resolution and sensitivity will allow us to detect companions as close as ~5au, over a completely unexplored range of primary masses. The proposed comprehensive study of multiplicity among this unique sample of young (1 to 10Myr) Upper Sco and Taurus free floating planets will provide serious constraints for the theories of formation and allow to better understand the respective contributions of these different processes to the final free-floating planet population, with important implications on brown dwarf and planet formation.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17168
Program Title: Confirming the Protoplanet Candidate AB Aur b with Accretion Light Echoes

Principal Investigator: Bowler, Brendan

PI Institution: University of Texas at Austin

Giant planets generate accretion luminosity as they form. Much of this energy is radiated in the form of strong Halpha line emission, enabling direct constraints on accretion mechanisms in the plaentary regime and the transport of material from circumplanetary disks onto young planets. However, compact disk features can mimic accreting planets by scattering Halpha emission generated by the host star; this can greatly complicate the interpretaion of point sources detected within protoplanetary disks. Recently a protoplanet candidate was directly imaged in Halpha with HST inside the transition disk of the young Herbig Ae/Be star AB Aurigae. We propose a novel test of the protoplanet hypothesis in this system using accretion light echoes by assessing whether the emission line strength is correlated between the candidate planet and the host star---a measurement only possible with HST. Strong positive correlation would point to scattering whereas no correlation would support the planet interpretation. If confirmed, this protoplant would explain many substructures in the AB Aur disk and would join only two other uncontested accreting giant planets detected with direct imaging.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17169
Program Title: Revealing the link between strong LyC emitters and enigmatic CIV emitters

Principal Investigator: Schaerer, Daniel

PI Institution: University of Geneva, Department of Astronomy

CIV 1550 emission is exceedingly rare in low-redshift star-forming galaxies but has been detected in increasing numbers at high-redshift (in lensed galaxies at z~2-3 and up to z~6-7). The nature of this emission, which requires relatively hard ionizing spectra, is currently unknown and highly debated. STIS observations of Lyman continuum (LyC) emitters at low-redshift have just revealed intense nebular CIV1550 emission and high ratios of CIV 1550/ CIII]1908 in all galaxies with cosmologically-important escape fractions fesc>0.1. This suggests empirically a link between LyC escape and carbon emission lines, which - if confirmed - would both have important applications for searches of the sources of cosmic reionization (with JWST and from the ground), and could explain the enigmatic CIV emitters. The discovery of new strong LyC emitters from the Low-redshift Lyman Continuum Survey provides a unique chance to place these exciting results on a more firm base. To do so, we propose STIS observations of ten newly discovered strong leakers to obtain their UV spectra covering all major emission lines between 1200 and 2000 Ang (i.e. Lyman-alpha, HeII, CIV, CIII], OIII], and others). The observations will increase by a factor of ~3 the number of spectra of strong leakers and be compared to a control sample of the same size. Together with existing+scheduled observations, we will thus obtain a sample of 26 star-forming galaxies with full spectral coverage from the Lyman Continuum to ~2000 Ang restframe. This will represent an important HST legacy for studies of the sources of cosmic reionization, with numerous applications and potentially far-reaching implications.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 17170
Program Title: Measuring the Effect of Progenitor Metallicity on Type Ia Supernova Distance Estimates

Principal Investigator: Siebert, Matthew

PI Institution: University of California - Santa Cruz

Despite using Type Ia supernovae (SN Ia) to precisely measure cosmological parameters, we do not know basic facts about the progenitor systems and explosions. Theory suggests that SN Ia progenitor metallicity is correlated with peak luminosity, but not how quickly it fades, which we use to calibrate the luminosity and measure distances. This effect should lead to an increased Hubble scatter, reducing the precision with which we measure distances. If the mean progenitor metallicity changes with redshift or population, cosmological measurements such as the dark energy equation-of-state parameter and the Hubble constant could be biased. Models also indicate that changing progenitor metallicity will have little effect on the appearance of optical/NIR SN data, but significantly alter UV spectra. These data can only be obtained with HST. HST observations of 2 "twin" SN (having nearly identical optical spectra and light-curve shapes) with different UV spectra and peak optical luminosities indicate progenitor metallicity differences consistent with models. The current sample of SN Ia with near-peak spectra is siginificantly lacking in its representation of high-velocity (HV) SN Ia. To determine the overall impact of progenitor metallicity on cosmological measurements, we must increase this sample. The community now discovers ~20 SN Ia each year >2 weeks before peak. With the increased discovery rate of young SN, we can expect to observe 4 HV SN Ia in the UV in a single Cycle and constrain how velocity affects the diversity of SN Ia UV properties. This is our best opportunity to further our understanding of SN Ia while directly improving the utility of SN Ia for cosmology.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17171
Program Title: Uncovering the Lyman continuum SED of star-forming galaxies from ~550 to 912 Angstroem

Principal Investigator: Schaerer, Daniel

PI Institution: University of Geneva, Department of Astronomy

The Lyman continuum (LyC = hydrogen-ionizing radiation at wavelengths < 912 Ang) of galaxies plays a fundamental role in determining the physical and observational properties of the ISM and IGM, including cosmic reionization. Yet it is basically inaccessible to direct observations, and one therefore heavily relies on theoretical, yet untested predictions from synthesis models. Furthermore the ionizing spectra differ significantly between different models, with important implications on widely used emission line diagnostics and other observables. We here propose to observe for the first time the shape of the ionizing continuum of star-forming galaxies over a wide spectral range, from ~550 to 912 Angstroem. This can be achieved with COS by targeting LyC emitters at z~0.8-1. The observations will measure stellar and nebular features in the LyC, and thus provide direct constraints for stellar population models in this generally inaccessible part of the spectrum. The proposed observations will provide unique insight on the hardness of the ionizing spectra of star-forming galaxies, with numerous possible implications on our understanding of the emission line properties of distant galaxies, sources of cosmic reionization, emission line diagnostics, and related topics.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17172
Program Title: Caught in the act: Galaxy quenching beyond the core of a redshift two galaxy cluster?

Principal Investigator: Canning, Rebecca

PI Institution: University of Portsmouth

Cluster environments in the local universe are dominated by passive, quiescent galaxies while proto-clusters at z>2 typically contain large fractions of actively star-forming galaxies. The physics underlying this observed transformation of the cluster member population has been a long standing puzzle in astronomy. The cluster quenching efficiency appears to rapidly increase over cosmic time but whether this is due to the pre-processing of galaxies in group environments prior to infall or occurs during accretion into the cluster itself is unknown. Our understanding has been limited by the lack of virialized clusters discovered at the critical transformational redshift of z~2, until now. We propose HST observations of XLSSC 122 - the highest redshift (z=1.98), virialized, massive galaxy cluster. We will utilize G141 grism observations to determine the redshifts of galaxies out to twice the cluster virial radius and combine these with WFC3 F140W/F105W and ACS F814W imaging to constrain the star-formation activity in these galaxies. These data will provide unique, unparalleled insight into the cosmic evolution of environmental quenching and unveil its impact in the cluster outskirts and in nearby groups and filaments.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17173
Program Title: Correcting for the Effects of Interstellar Extinction Toward the Roman Galactic Exoplanet Survey Fields

Principal Investigator: Nataf, David

PI Institution: The Johns Hopkins University

The upcoming Roman Galactic Exoplanet Survey will revolutionize exoplanet studies: expected detections of 100,000 transiting planets and 2000 microlensing planets, including sensitivity to planets with masses as low as Mars for orbital radii of 3 AU. Meaningful interpretation of this bounty will require knowing the properties of the planet host stars. But, as these stars lie toward the inner Galaxy, foreground extinction will typically be >10x higher than it is toward either of the Kepler or TESS fields. Worryingly, in addition to the high total extinction, the wavelength dependence of the extinction toward the inner Milky Way is known to be both spatially variable and different from the "standard" extinction curve. These factors necessitate a robust three dimensional mapping of the interstellar extinction and the interstellar extinction curve toward the inner Milky Way. We request 7 orbits to measure the interstellar extinction curve for a representative sample of these sightlines. To break the degeneracies that have previously limited study of this phenomenon, we propose to study the extinction in two bands that are not accessible from the ground (F098M, F139M), complemented with three other bands selected for efficiency and calibration purposes (F130N, F153M, F167N). These observations, when combined with a preexisting suite of measurements at other wavelengths, will enable a full characterization of the extinction curve and its variations toward the sightlines of the Roman Galactic Exoplanet Survey, enabling both improved forward modelling of the survey and, crucially, more robust estimates of the stellar parameters of transiting and microlensing planet host stars.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17174
Program Title: New Kids on the Block? Proper Motions of First Infall Galaxies in the Local Group

Principal Investigator: Bennet, Paul

PI Institution: Space Telescope Science Institute

The Local Group (LG) is dominated by the Milky Way (MW), Andromeda (M31) and Triangulum (M33) galaxies. Their inner satellite systems have been well studied, but there are galaxies that live at the edges of these systems whose nature and histories are poorly understood. They trace a key part of the host's mass distribution not probed by closer-in satellites. We propose to measure proper motions (PMs) for 4 such LG dwarf galaxies: LeoT (MW satellite), Aquarius (M31), Pegasus (M31), and Pisces (M31 or M33?). Combining the new HST PMs with existing line-of-sight velocities, we will precisely determine their orbits, and compare the orbital characteristics and timescales with their existing SF histories. This will enable us to address several key questions. Are they bound or unbound to their putative hosts? Are they falling in to their hosts for the first time or have they fallen in before and splashed back again? Their infall is thought to trigger a burst of star formation (SF) and then quench, but on what timescales, and at what distance from the host do these events occur? What are the outer mass distributions of their hosts, and the mass of the LG as a whole? Is Pisces the first known satellite of M33? The target galaxies are too far and faint for Gaia to study. Only HST has the depth, astrometric precision and long time baselines via its Archive to measure these PMs. With Hubble's exceptional longevity and stability, we are able to continue to push back the frontiers of LG science.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17175
Program Title: Mapping the diversity of kilonovae through rapid Hubble observations of a short gamma-ray burst

Principal Investigator: Troja, Eleonora

PI Institution: Universita di Roma Tor Vergata

Mergers of two compact objects, either two neutron stars (NSs) or a NS and a stellar mass black hole (BH), are astrophysical sources of great interest. Their observations enable for multi-disciplinary studies encompassing several key fields of modern astronomy: from the cosmic production of heavy metals to the formation and acceleration of relativistic outflows, and to the behavior of dense matter in extreme physical conditions. Future gravitational wave (GW) detections will probe these systems in the local universe, while gamma-ray bursts (GRBs) offer a unique route to study their evolution across cosmic time and assess the role of these systems in shaping the cosmic chemical evolution. We propose rapid HST ToO observations of newly discovered short GRBs to pin down the fingerprints of heavy elements in their light, the so-called kilonova, and search for evidence of magnetar formation. These measurements will be leveraged with a multi-wavelength (from radio to X-rays) observing campaign, and represent a natural stepping stone for the James Webb Telescope. Even a single new event observed through the combined power of these facilities will push the frontier of our knowledge a step further and provide us with a benchmark dataset to constrain the nucleosynthetic yields of NS mergers.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17176
Program Title: The Innermost Regions of FU Ori Disks: A Spectral Legacy for HST/STIS+COS

Principal Investigator: Hillenbrand, Lynne

PI Institution: California Institute of Technology

FU Ori stars are a rare class of young stellar object, with less than two dozen examples known. Yet the long-lasting FU Ori outburst events play a prominent role in our understanding of stellar mass assembly at the individual star level. The currently favored model is that of an inner disk instability causing a factor of 100-10,000 increase in the disk-to-star accretion rate. Ultraviolet observations are the most direct way to test the accretion disk scenario -- by measuring the hottest part of the inner disk and thereby determining physical parameters such as temperature T_max and temperature profile T(R). We propose here a complete STIS+COS legacy spectrum for the prototype of the class, FU Ori itself (11 orbits), plus a STIS low-resolution NUV spectral survey for four additional FU Ori outbursts (10 orbits). Heating by viscous accretion will be tested by (1) comparing the new data on FU Ori to a previous STIS spectrum obtained 20 years ago, to look for evidence of disk cooling, and (2) comparing the maximum disk temperature across the five targets, which span a factor of 6 in luminosity. These tests can only be done in the NUV, which is sensitive to the hottest disk temperatures. The spectra will be interpreted using a new empirical disk model that has been applied successfully to longer wavelength observations of FU Ori stars. This survey of extreme accretion disks provides an important complement to the ULLYSES DD Spectroscopic Legacy Project, developed to evaluate magnetospheric accretion on typical T Tauri stars. Our program focuses on the extreme state of accretion physics for young stars, with importance for the evolution of the star and the disk.

Proposal Category: SNAP
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17177
Program Title: Snapshot survey of host galaxies of active 'light-weight' supermassive black holes

Principal Investigator: Chilingarian, Igor

PI Institution: Smithsonian Institution Astrophysical Observatory

Low-mass (under 1,000,000 MSun) supermassive black holes (light-weight SMBHs) are critical to solve one of the long-standing problems in modern astrophysics, the origin of SMBHs. Their host galaxies hold important clues to our understanding of galaxy formation and evolution processes: they might have evolved from ancient times in the early Universe without major merger events or intense gas accretion on-to their nuclei and, therefore, represent the relics of primordial galaxy formation. Using optical selection of AGN features and data from X-ray archives, we confirmed 124 light-weight active SMBHs, only 8 of which have available HST images. Here we propose to carry out near-UV/optical imaging of the 116 remaining light-weight SMBH host galaxies using HST WFC3 in the form of a SNAP program, boosting HST-observed light-weight SMBHs by larger factors. This project will yield sizes, luminosities, and stellar populations of a statistically significant sample of hosts, and probe whether the MBH-Mbulge scaling relation holds in the low-mass regime and central low-mass black holes do indeed co-evolve with host galaxy spheroids.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17178
Program Title: The Blue Edge of the Helium White Dwarf Instability Strip

Principal Investigator: Provencal, Judith

PI Institution: University of Delaware

Aims: This proposal focuses on obtaining accurate temperatures and abundances for white dwarfs near the blue edge of the helium instability strip. Context: The observed location of the helium white dwarf instability strip in the temperature/log g plane is a strong indicator of convective efficiency in WD atmospheres, and by extension in all stellar envelopes. The blue edge's location was considered well established until the confirmation by Kepler K2 that the hot DB PG0112+105 is a pulsator. The empirical blue edge of the instability strip is now unknown. Uncertainties as large as 3000 K in the optical spectroscopic temperature scale for DBs presents considerable problems in accurately the location of the blue edge through optical data alone. Obtaining UV spectra and light curves of DBs near the blue edge of the DB instability strip will provide a definitive location in the temperature/log g plane for the initiation of pulsations. This result can then be used to 1) calibrate mixing length theory used in all stellar models, 2) validate 3D hydrodynamic simulations, 3) constrain contributions of different driving mechanisms initiating pulsations, and 4) improve our understanding of mixing and diffusion of different elements in white dwarf convection zones.. Methods: This proposal presents the justification for COS observations of 6 DB white dwarfs with temperatures between 35,000 and 29,000 K. The observations will determine 1) accurate temperatures, surface gravities, and chemical abundances, 2) determine if each target is pulsating and lies in the strip, and 3) determine an accurate empirical blue edge for the helium instability strip.

Proposal Category: SNAP
Scientific Category: Stellar Physics and Stellar Types
ID: 17179
Program Title: A public HST-UV snapshot survey of type Ia supernova host galaxies with pre-existing optical integral-field spectroscopy

Principal Investigator: Galbany, Lluis

PI Institution: Institute of Space Sciences (CSIC-IEEC)

We propose a public UV survey of Type Ia supernova (SN Ia) host galaxies to provide environmental insights into their progenitor systems. Understanding the progenitors of SNe Ia is vital to reduce systematic uncertainties in their standardization to measure extargalactic distances and to constrain cosmological parameters. Despite surges in SN Ia discoveries, direct progenitor constraints are elusive, and so environment and host galaxy studies, through analysis of the coeval stellar populations, offer valuable alternate routes to perform large-scale population studies. UV coverage is uniquely afforded by HST and a key window into star formation and young stellar populations. Crucially, the targets have been selected by having pre-existing integral-field spectroscopic (IFS) observations. Galaxy studies have undergone a resurgence with the advent of new IFS instruments, allowing spatially-resolved spectroscopic studies across entire galaxies, but suffer from a lack of wavelength coverage. The UV data proposed is essential to derive meaningful properties of young stellar populations. This will provide the age resolution in stellar population fitting to, for the first time, directly measure the delay-time-distribution of SNe Ia and assess the turn-on timescale at which the youngest SN Ia progenitors explode. Such a data set will have legacy for a multitude of galaxy studies and we are committed to making our joint UV+IFS dataset and analysis public.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17180
Program Title: What's hidding in the neutral gas? Dissecting the different metallicity components in NGC 1313

Principal Investigator: Hernandez, Svea

PI Institution: Space Telescope Science Institute - ESA - JWST

Metallicity is a critical parameter shaping the evolution of galaxies on cosmic timescales. In spite of the importance of this single parameter and the variety of tools available to investigate its distribution in star-forming galaxies, detailed comparisons of the abundances obtained from the ionized-gas, neutral-gas, and stellar components are still lacking to fully understand the chemical state and evolution of galaxies. We propose to remedy the situation by exploiting the unique capabilities of HST/COS in the FUV regime, acquiring and analyzing G130M/1291 spectroscopic observations of 7 pointings (2 archival + 5 new) in the low-metallicity environment of NGC 1313. The data will provide a rich assortment of neutral-gas metallicity tracers allowing us to assess the abundances of the neutral ISM and estimate the stellar metallicities of the targeted stellar clusters. Our study will combine the metallicities of the neutral gas and stellar populations with existing abundances of the ionized gas, performing the first co-spatial comparison of these three components in a low metallicity system, investigating the degree of homogeneity between the stars and multi-phase ISM across the galaxy on spatial scales of ~55 pc. This complete and inexpensive study in the barred spiral NGC 1313 will uncover the links between the different internal components (stars, neutral and ionized gas), and their precise roles in moderating the mixing timescales and star formation in galaxies.

Proposal Category: SNAP
Scientific Category: Stellar Physics and Stellar Types
ID: 17181
Program Title: A public survey of superluminous supernovae hosts to study their progenitors

Principal Investigator: Lyman, Joseph

PI Institution: The University of Warwick

Superluminous supernovae (SLSNe) are incredibly luminous signposts indicating our understanding of massive stellar evolution is lacking. They are rare transients peaking at luminosities 100 times those of typical supernovae, and are not explicable by the current paradigm of iron-core collapse in massive stars. As such, alternative competing models have arisen to explain their explosion mechanism, each with consequences for the putative progenitor systems. The nature of SLSN progenitors, primarily their age and metallicity, are shared with their parent stellar population, thus, as with other transients, study of the environments has proved fruitful. Early work with HST looking at the resolved host galaxies of SLSNe has revealed tenuous constraints for the progenitors, such as a preference for low-mass, compact star-forming hosts. Recent surges in discovery and classification of SLSN mean the sample is now over 200 events, most from the last few years. This public survey will provide a corresponding surge in the number of SLSN host galaxies observed with high-resolution UV imaging, to allow environment work by the community to keep pace with the burgeoning samples. HST uniquely affords the near-UV depth and spatial resolution to study the morphology and sizes of the compact host galaxies. Crucially, the location of the SLSNe can also be pinpointed within their hosts to identify the parent stellar population. By comparing SLSN environments to those of core-collapse SNe, gamma-ray bursts, and theoretical expectations from progenitor models, the new sample will allow for robust constraints to be made for the progenitor systems, even across SLSN sub-types.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17182
Program Title: The hot remnant core of the mass donor in a unique Be star binary HD 92406 - two stellar eclipses and two disk occultations per orbit

Principal Investigator: Labadie-Bartz, Jonathan

PI Institution: University of Delaware

About 20% of the B-type stars are rotating very rapidly. Among these are the classical Be stars, which eject material and build up gaseous circumstellar 'decretion' disks. Rotation plays a significant role in the structure and evolution of massive stars, yet in many aspects is poorly understood. One viable evolutionary pathway to acquire near-critical rotation is through binary interaction - namely mass and angular momentum transfer. The remaining core of the mass donor is now a hot stripped star. Some models suggest the binary channel is dominant in creating rapid rotators. Yet, only about 15 rapidly rotating Be + stripped star binaries are known, virtually all of which were detected and characterized with UV spectroscopy. This proposal aims to characterize a new Be + stripped star binary, HD 92406, using HST UV spectroscopy. HD 92406 is exceptionally valuable as there are two stellar eclipses and two disk occulations per binary orbit - this is the only known eclipsing binary that hosts a Be star. HD 92406 is the first putative late-type Be + stripped star binary, occupying a unique niche in the rapidly rotating binary population. UV spectroscopy taken at two specific orbital phases (one when the sdO is hidden behind the Be star) offers the unique opportunity to measure directly the spectrum of an sdO star for the first time. With that, the parameters of the stripped star in HD 92406 can be determined with sufficient precision to reveal its evolutionary tracks via comparison with binary evolution models. A full analysis promises to make this a benchmark system, with properties determined with far higher precision than what is typically possible.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17183
Program Title: Hubble Ultraviolet-optical Survey of Transiting Legacy Exoplanets (HUSTLE) treasury program

Principal Investigator: Wakeford, Hannah

PI Institution: University of Bristol

The UV contains unique constraints on the atmospheric properties of a planet. Yet, the UV is an often overlooked wavelength region for exoplanet studies despite the wealth of information it contains on aerosol scattering properties and unknown absorbers. We propose to conduct a Hubble Ultraviolet-optical Survey of Transiting Legacy Exoplanets (HUSTLE) treasury program using the newly proven capabilities of the WFC3/UVIS G280 grism to produce a spectroscopic survey of 14 exoplanet atmospheres from 200-800nm. G280 has the highest throughput among all Hubble's UV instruments, making it an important instrument for the future of UV exoplanet science. This program targets giant planets from warm Neptunes to ultra hot Jupiters with equilibrium temperatures from 900-2600K, spanning a broad range of chemical, aerosol, and irradiation conditions. This treasury program will expand Hubble's UV legacy for exoplanet studies, and in doing so, will address several important science questions: 1) place constraints on aerosol particle sizes, altitudes, and vertical mixing of clouds on the planetary limb, 2) identify and constrain the abundance of any Mid to Near-UV absorbers, and 3) leverage these directly measured properties to create legacy datasets to facilitate comparative studies, adding to our understanding of the mechanisms that sculpt these worlds. Our target list includes a number of well known exoplanets that have formed the basis of our understanding of these extreme atmospheres and are already targets for Webb. The HUSTLE treasury program will provide the critical missing puzzle pieces to ensure that we can view the full picture of exoplanet atmospheres now and in the future.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17184
Program Title: Signatures of neutron star mergers hidden in Gaia Enceladus?

Principal Investigator: Skuladottir, Asa

PI Institution: University of Florence (Italy)

The production sites of heavy elements such as Eu and Au are hotly debated. Observational evidence strongly indicates two main sites for the r-process: Neutron star mergers (NSM), and a subset of core-collapse supernovae (r-ccSN). The key question is: What is the difference between the heavy elemental abundance pattern produced by NSM and r-ccSN? This can be answered by looking at stars that have been independently enriched by each source. This is possible by comparing the properties of stars born in the r-process rich accreted galaxy Gaia Enceladus, which is believed to be primarily enriched with NSM, with those stars born in the Milky Way, predominantly enrichment by r-ccSN. For this purpose, a sample of stars with both these origins has been awarded time for high-quality VLT/UVES observations to characterise their chemical signatures. However, many of the key r-process elements are inaccessible from the ground, making HST fundamental for a comprehensive comparison between the two r-process sites. Thus we ask for STIS MAMA HR spectra to measure the detailed r-process abundance pattern for 4 bright stars from the UVES sample: 2 that have primarily been enriched by NSM (Gaia Enceladus), and 2 that are dominated by r-ccSN (the Milky Way). This will be the first time several third peak elements (e.g. Pt, Au) are measured in stars formed outside of the Milky Way, and the combined HST+VLT spectra will provide the most complete abundance pattern that has ever been obtained in an external galaxy. Most importantly, this programme is a unique and innovative way of observationally probing whether r-ccSN provide a different r-process abundance pattern to NSM.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17185
Program Title: How diverse is the bulk composition of exoplanetary material?

Principal Investigator: Rogers, Laura

PI Institution: University of Cambridge

As we move into an epoch of rocky planet detection and characterisation, it is crucial that we can measure the interior composition of exoplanetary material and understand exoplanet diversity. White dwarfs that have accreted chunks of exoplanets are unique laboratories to directly study the bulk composition of exoplanets and investigate geological processes in other planetary systems. We propose to observe 23 white dwarfs which have accreted significant chunks of planets. With Hubble UV spectra we will measure the composition of the parent body that accreted onto each white dwarf, which reveals the unique history of each exoplanet. We will more than double the number of white dwarfs with abundances of all major rock forming elements- moving the field from a story of individual discovery to population statistics. Using this statistical sample we will answer: how diverse is the bulk composition of exoplanetary material?

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17186
Program Title: The Origins and Evolution of Helium Atmosphere White Dwarfs

Principal Investigator: Provencal, Judith

PI Institution: University of Delaware

Aims: The proposed observations will conduct the first UV investigation helium atmosphere white dwarfs found within the "DB gap", and will determine their physical parameters. Context: The origin and evolution of helium atmosphere white dwarfs (DBs) is poorly constrained. White dwarfs are structurally simple; they consist of an electron degenerate core surrounded by an insulating blanket of hydrogen (DA) and/or helium (DB). Their evolution is dominated by secular cooling. The DB gap is a temperature range between 45,000 and 30,000 K where mostly DA white dwarfs are found. There is no readily apparent reason why this should be, so theories of white dwarf formation and evolution have been forced to scenarios that explain this gap. The Sloan Digital Sky Survey has revealed a population of DB white dwarfs that lie within this gap. Little is known about these objects besides their optical temperatures. The fundamental physical properties and chemical abundances of these objects can be used to test competing theories of white dwarf formation and evolution, leading to a better understanding of the white dwarf population and the final stages of stellar evolution. Methods: The proposal presents justification for COS observations of 2 DB white dwarfs with temperatures between 45,000 and 30,000 K. The observations will determine accurate effective temperatures, surface gravities and chemical abundances for each.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17187
Program Title: Observing the Ice Giants with Hubble WFC3 to Enhance Cycle 1 James Webb Space Telescope Data

Principal Investigator: Rowe-Gurney, Naomi

PI Institution: NASA Goddard Space Flight Center

The JWST will provide exceptional near- and mid-infrared spectral coverage of the Ice Giants via guaranteed time observations in Cycle 1 (Programs 1248 and 1249), capturing new, critical information on their atmospheric temperatures, their chemical structures, and the flow of energy between their cloud-forming weather layer and their middle and upper atmospheres. However, the JWST data cannot be interpreted reliably without context. JWST observations provide only brief snapshots of these two highly dynamic worlds, requiring temporal context to understand how the atmospheres have varied with time, and spatial context to understand the distribution of meteorological features during the JWST observations. The HST campaign offers a critical extension of spectral coverage into the visible that will be capable of detecting important features like dark spots and their bright cloud companions. HST is the only facility capable of the high-resolution at visible- specifically blue- wavelengths. We therefore propose a HST GO campaign using the WFC3 instrument in UVIS observing mode to provide complementary, comparative, and synergistic science alongside the JWST Cycle 1 Guaranteed-Time Observations (GTO) of these distant, cold, and exceptional worlds. From a strategic perspective, as the international planetary community looks ahead to future NASA and ESA missions to the ice giants, this combined Hubble and JWST campaign will pave the way for more robust understanding of these distant worlds.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17188
Program Title: Cosmic Beacons Towards a Theory of Massive Star Formation - A NIR View of the Most Luminous Protostars

Principal Investigator: Fedriani, Ruben

PI Institution: Chalmers University of Technology

Massive stars have dramatic impacts throughout the universe, but their birth, deep within dusty molecular clouds, is literally shrouded in uncertainty. However, during this process, powerful outflows blast open low density cavities and NIR light shines out from the forming star, beamed as if from a lighthouse through turbulent storm clouds. This light carries crucial information that can guide us to a deeper understanding of massive star formation. We propose WFC3/IR observations of 10 high-luminosity protostars, selected to already have well-studied properties via MIR-FIR data. The sources, along with 5 others with archival HST images, form a sample to be analyzed uniformly with the following goals: 1) Characterize J & H band continuum emission from massive protostars, including faint, extended emission. Radiative transfer simulations show such NIR emission is mostly scattered light emerging from outflow cavities, thus enabling measurement of their structure, radiation fields & dust content; 2) Detect Pa-beta & [FeII] emission tracing shock- & photo-ionized regions, important diagnostics of the protostars and their outflows; 3) Search for low-mass stars that may be clustered around the massive protostars, as predicted in Competitive Accretion models, with the observations especially probing in the low extinction outflow cavities. WFC3/IR's sensitivity, angular resolution and field of view are essential for this study. The project allows a first exploration of correlations of outflow and cluster environment properties with basic protostellar parameters, e.g., mass, luminosity & evolutionary stage, and thus enables groundbreaking tests of massive star formation theories.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17189
Program Title: A panoramic study of low-density star formation in XUV disk galaxy NGC 3621: Testing for environmental dependency of clusters, OB associations, and the stellar hierarchy

Principal Investigator: Thilker, David

PI Institution: The Johns Hopkins University

We propose an efficient yet panoramic UV-optical survey of the extended UV disk galaxy NGC 3621, with the goal of decisively evaluating various environmental dependencies of stellar cluster and OB association populations. Such work is very challenging in the regime of low-density star formation (SF) because large areas must be observed by HST to accumulate statistical samples. Consequently, our knowledge of the SF process, its products, and associated feedback in this extreme, but important, regime is woefully incomplete. Our program addresses this shortcoming in a finely controlled experiment using an otherwise well-studied target. The union of NGC 3621's inner and XUV disks presents an ideal test-bed because the local physical conditions change in a remarkably continuous radial manner, across our ~1400 sq.kpc HST footprint, that fully probes gradients in metallicity, plus stellar mass, gas mass and star formation rate surface density. Cluster and association counts will be high enough to bin versus environment for all our goals: (1) We will test predictions of SF modeling in low-density environments. Our program will provide decisive constraint on the extreme low end of predicted cluster formation efficiency, inform environment-driven models of cluster morphology, and determine whether continually dispersing remnants of SF activity are consistent with expectations. (2) The census of stochastic low-mass clusters and associations will provide a testbed for new models / analysis methods relevant to low-density SF. Our project is a vital step toward a full theoretical picture of SF and galaxy evolution in the vast majority of HI-dominated gas out to high redshift.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17190
Program Title: Will the Recurrent Nova T Pyxidis Become a Type Ia Supernova?

Principal Investigator: Godon, Patrick

PI Institution: Villanova University

The recurrent nova T Pyx has erupted six times since 1890. The last outburst in 2011 offered a unique opportunity to catch T Pyx with HST as it transited into quiescence. The system has now passed its nebular phase and settled into a deep quiescence state where the UV and optical emissions are dominated by the accretion disk. Earlier HST COS observations have provided FUV spectroscopy showing the decline phase and indicating that T Pyx is accreting at a very high rate. As a result, the T Pyx WD might be growing in mass, and therefore may be on its way to explode as a Type Ia supernova (SN Ia). HST STIS optical spectra were obtained during the nebular phase to study the expanding nebular material, but no STIS optical spectra have yet been obtained during the quiescent phase to help derive an accurate mass accretion rate: to model the disk properly UV and optical spectra must be collected because the inner disk dominates in the FUV and the outer disk dominates in the optical. We request the first combined optical (STIS) and FUV (COS) spectroscopic observation of T Pyx during the deep quiescent phase to properly model the disk and derive an accurate mass accretion rate. In addition, we will measure the width and velocity of the hydrogen and helium lines to better model the inner disk (lines in emission) and outer disk (lines in absorption). These observations will assess whether the T Pyx WD mass is growing, and hence whether T Pyx is indeed a viable SN Ia progenitor. Even though SNe Ia are the tools used to demonstrate that the Universe is accelerating, the exact nature of SN Ia progenitors has not been confirmed.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17191
Program Title: Tripling the sample of late-time Type Ia supernovae

Principal Investigator: Graur, Or

PI Institution: University of Portsmouth

Type Ia supernovae (SNe Ia) have long been used as standard candles to measure extragalactic distances and cosmological parameters. SNe Ia are portrayed as a homogeneous class, but there are actually several subtypes. Even the "normal" SNe Ia used for cosmology may not be homogeneous. Recently, the optical light curves of SNe Ia have been shown to slow down, relative to their earlier decline rate, at >800 days after explosion. Moreover, more luminous SNe Ia may slow down faster than less luminous objects. This correlation, which recalls the peak-light stretch-luminosity relation used to standardize SNe Ia, also hints at the existence of several production channels for normal SNe Ia, as no single explosion model can produce the full range of late-time light curves. But this new correlation is based on just 6 objects. We ask for 67 WFC3/UVIS orbits (with the F438W, F555W, and F814W filters) spread over Cycles 30-32 to observe 12 SNe Ia when they are 600-1200 days old. By tripling the sample of late-time SNe Ia, we will prove the existence of the new stretch-luminosity correlation at a significance of >5-sigma. The impact on SN cosmology will be twofold. First, a new stretch-luminosity correlation could further standardize SNe Ia and reduce systematic uncertainties. Second, strong evidence for the existence of multiple production channels for normal SNe Ia would force cosmologists to revisit their use of SNe Ia as a monolithic class. This experiment is time critical. Every year, on average, <5 SNe Ia can be used for this experiment. We are lucky to have 12 targets to work with this year; this chance may not come again during HST's remaining lifetime.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17192
Program Title: The SPACE Program: a Sub-neptune Planetary Atmosphere Characterization Experiment

Principal Investigator: Kreidberg, Laura

PI Institution: Max Planck Institute for Astronomy

The HST-TESS Exoplanet Initiative (HTEI) was recently recommended by STScI to capitalize on the wealth of nearby sub-Neptunes discovered by the Transiting Exoplanet Survey Satellite (TESS). Even though sub-Neptunes are very common, there are still major open questions about how they form and evolve. Direct measurements of their atmospheric composition are a powerful tool to distinguish between different formation models. Fortunately, the abundance of new TESS discoveries provides an opportunity to systematically study sub-Neptune atmospheres for the first time. Here we propose a community-driven HTEI Program: SPACE (the Sub-neptune Planetary Atmosphere Characterization Experiment). The SPACE Program will combine UV stellar characterization with WFC3 transmission spectroscopy for eight sub-Neptune systems. The targets span a physically-motivated grid across planet radius (2 - 3.5 Re) and temperature (300 - 1400 K), specifically designed to reveal how sub-Neptune atmospheres are shaped by UV photochemistry, equilibrium cloud formation, atmospheric metal enrichment, vertical mixing, and photoevaporation. The UV spectra are urgently needed because they are a crucial input for photochemistry and atmospheric escape models, and can only be obtained while HST is still operational. With these measurements, SPACE will extend HST's exoplanet legacy from hot Jupiters to the much more abundant sub-Neptunes, to rapidly establish demographic trends and identify cloud-free atmospheres for future follow-up of this exciting population.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17193
Program Title: WO-type Wolf-Rayet Stars: The Last Hurrah of Massive Stars

Principal Investigator: Massey, Philip

PI Institution: Lowell Observatory

The WO class of Wolf-Rayet (WR) stars represent the most evolved type of massive star: their last hurrah before they undergo core-collapse. Abundance determinations of WOs thus give us a glimpe of the nucleosynthsis of massive stars at the very end of their lives, providing an unprecedented test of stellar evolutionary theory. We have recently finished an analysis of two WOs in the Large Magellanic Cloud (LMC) in order to determine their physical properties, including their abundances. Our results imply that the nuclear reaction rate for 12C+4He-->16O (long known to be uncertain) must be significantly lower than what is used in modern evolutionary models. This has enormous implications: among other things, it would eliminate the conflict between the theoretical black hole upper mass gap and the large black hole masses revealed by various gravitational wave events. Yet, our result hinges on the analysis of only two stars. WO-type WRs are rare: there are only three in the LMC, and the handful known in the Milky Way and in other galaxies are too reddened or distant to obtain the high-quality UV spectra necessary for their analysis. Unfortunately, the third LMC WO star, LH41-1042, has a companion only 0.1" away. However, by carefully aligning one of the narrow STIS slits, we can obtain a nearly uncontaminated spectrum of this third WO with just seven orbits. These data will provide an important test of our conclusion that the 12C+4He-->16O nuclear reaction rate is too high. LH41-1042 is the only remaining WO star that can be observed in both the UV and optical; obtaining these data can only be done with HST.

Proposal Category: SNAP
Scientific Category: Galaxies
ID: 17194
Program Title: Local Environments of Low-redshift Type Ia Supernova Siblings

Principal Investigator: Kelsey, Lisa

PI Institution: University of Portsmouth

Type Ia supernovae (SNe Ia) have a low intrinsic magnitude dispersion, therefore are highly standardisable and make excellent cosmological distance indicators. After correcting for light-curve properties, such as width (stretch) and intrinsic colour, this dispersion is further reduced. However, an intriguing dependence on SN host galaxy properties remains: SNe Ia associated with high mass hosts are brighter than those in low mass hosts. If the remaining brightness dispersion is entirely due to global host galaxy properties, SNe Ia associated with the same galaxy (siblings) should be cosmologically similar, with comparable intrinsic colours, stretches and Hubble residuals. However, prior studies have shown that this is not the case, and they are as different as any other pair of SN. With the high quality images we will obtain with this proposal, we will investigate the local environments of a sample of low redshift (low-z) siblings, by measuring rest-frame U-R photometry within small apertures around each SN, to see if sub-galactic differences in environmental properties are the answer to improving SNe Ia standardisation. Prior sibling analyses have typically been limited to the duration of individual surveys, meaning that their sibling samples have primarily been found in high mass, elliptical galaxies, which are associated with higher rates of SNe Ia. Our proposed sample of archival low-z siblings differ in explosion times by an average of 14 years allowing for an increased understanding of the rates of sibling SNe Ia, detailed investigation of a diverse variety of host galaxy morphologies, and thus a diverse range of local environments within those galaxies.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17195
Program Title: UV Spectroscopic Signatures from Fast Evolving Transients

Principal Investigator: Fox, Ori

PI Institution: Space Telescope Science Institute

A new subclass of fast rising and fading transients is being uncovered as higher cadence all-sky surveys come online (e.g., ZTF, YSE), including FBOTs and supernovae (SNe) Type Ibn/Icn. This subclass generally tends to be described as "extreme" given they are some of the hottest, bluest, most luminous, and fastest evolving transients known, defying our current understanding of stellar evolution and explosions. While shock interaction with a dense circumstellar medium is likely, other powering mechanisms may be at play. Yet compared to other SNe, very little is known about these events. One of the reasons is that the optical spectra tend to be dominated by a featureless continuum. The UV, however, provides an important window by which to study these events, as a significant amount of energy emerges at these wavelengths and a multitude of emission lines probe the abundances of both iron-group and intermediate-mass elements. Recent advances in theoretical models (CMFGEN, specifically) now allow for the treatment of these fast transients, including in the UV. While several UV spectra exist, they do not adequately span the known diversity of this subclass. Furthermore, they tend not to be obtained early enough relative to peak to build a complete model of the event (e.g. CSM composition and mass, energetics). Published spectra offer qualitative comparisons, but do not perform any detailed modeling. Here we propose a disruptive ToO with HST/STIS to obtain 2 epochs of UV spectra of a fast transient within 250 Mpc. Follow-up modeling will result in a detailed probe of mass-loss history and powering mechanism in this extreme(!) new subclass.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17196
Program Title: Identifying the Hydrogen Excess in the Stagnation Region at the Heliospheric Interface

Principal Investigator: Clarke, John

PI Institution: Boston University

The nature of the interaction of the solar wind with the interstellar medium at the heliospheric interface has been the subject of much study with Voyagers 1 and 2, ground-based telescopes, and the IBEX mission. Theoretical models for the nature of the interaction still do not conform to the experimental data, including the presence of excess hydrogen Lyman-alpha emission in the interface region. One of the main puzzles is the nature of the so-called stagnation region at the boundary between the solar wind and interstellar medium, for which there is evidence in Voyager and New Horizons data. The indications are that this region is characterized by a population of high velocity H atoms, which can be used as a remote diagnostic. It is also possible that part of the excess emission is from galactic Lyman-alpha, as modeled for the Voyager UV data. This program will use STIS echelle line profiles of the interplanetary H Lyman-alpha emission to map the velocity distribution and either identify or rule out the presence of either a population of H atoms in the "stagnation" region of the heliospheric interface or diffuse emission from the galaxy. This is not possible in existing HST data sets due to the interference of geocoronal emission with the expected high velocity wings of the emission lines.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17197
Program Title: Proper Motions of Extragalactic Jets with HST: A New Epoch

Principal Investigator: Meyer, Eileen

PI Institution: University of Maryland Baltimore County

While we have long known that jets from super-massive black holes exhibit highly relativistic speeds on parsec scales from radio interferometry, it is not generally known how the jet evolves on kpc to Mpc scales, where the jet leaves the host galaxy and begins to interact with the intergalactic medium, with implications for our understanding of jet structure and quantifying the energy carried by the jet into the external environment. With the development of state-of-the-art astrometry techniques and new data from the Gaia mission, it is now possible register images of nearby jets first observed by HST in the 1990s to extremely high precision, reaching accuracies on proper motions of better than 0.3 mas/year. This enabled the dramatic finding of colliding superluminal knots in the jet of 3C264 and helical motions of plasma on kpc scales in M87. We propose a new epoch on the 7 remaining nearby optical jets which have been previously observed by HST for proper motions. This sample is an extremely unique one, and only HST can provide the precision astrometry and sensitivity needed to track the motion of plasma in jets on kpc scales.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17198
Program Title: First look at the high-ionization UV nebular emission powered by the youngest stellar populations below 5% solar metallicity: the missing link to the reionization era?

Principal Investigator: Senchyna, Peter

PI Institution: Carnegie Institution of Washington

Despite a substantial investment of HST orbits over the last five years, the intense nebular CIV detected at z>6 remains mysteriously without precedent among star-forming galaxies in the local Universe. The persistent difficulty in interpreting this emission with the launch of JWST looming foreshadows potentially significant challenges in the coming years. Uncertain photoionization models suggest that extraordinarily metal-poor massive stellar populations at <5% solar are likely to be the most efficient engines for this high-ionization emission. However, UV and most optical observations have so far been restricted to relatively bright and unfortunately low specific star-formation rate regions at these lowest metallicities. The relatively recent unveiling of a significant population of extremely metal-deficient galaxies dominated by young stars below the detection limits of previous surveys promises to at last open a window onto the highly uncertain ionzing spectrum of massive stellar populations below 5% solar. Here we propose G160M observations to constrain CIV and HeII at gas-phase oxygen abundances below 5% and effective ages <~5 Myr for the first time, targeting the only three systems known in this regime which are sufficiently bright and low-redshift to be amenable to relatively inexpensive UV spectroscopic follow-up. These data will provide unique insight onto the high-energy radiation fields powered by very low-metallicity massive stars, immediately either resolving or significantly heightening the tension between local galaxy populations and the first systems targeted with rest-UV spectroscopy in the reionization era.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 17199
Program Title: Time-delay Cosmography with Strongly Lensed Quasars: Doubles vs. Quads

Principal Investigator: Lemon, Cameron

PI Institution: Ecole Polytechnique Federale de Lausanne

Time delays of strongly lensed quasars provide an independent cosmological probe that is primarily sensitive to the Hubble constant, H0. The method relies on precise time-delay measurements from photometric monitoring of the quasar images, which has been accomplished so far for only 7 systems, including 6 quadruply imaged quasars (quads) and 1 doubly imaged quasar (double). With deep HST images and ground-based follow-up, the latest results give H0 = 73.7 +/- 1.5 km/s/Mpc, compatible with distance ladder measurements but in tension with Planck. Intriguingly, the one double yields the lowest value of H0. With the present HST WFC3 imaging proposal our goal is to obtain deep and sharp images of 8 doubles with precisely measured time-delays from decade-long monitoring campaigns and all other necessary ancillary data already in hand. This will make the number of doubles useful as cosmological probes comparable to that of quads, and 1- test for modelling systematics by separately considering doubles and quads, 2- demonstrate the potential of doubles, i.e. 85% of the lens population, for time-delay cosmography, which is particularly important in the context of Rubin-LSST, 3- measure H0 to 2.2% precision under the assumption of physically motivated models with doubles alone, 4- in the case of no modelling systematics between quads and doubles, to measure H0 to 1.6% in combination with quads, i.e. competitive to the best probes such as type-Ia supernovae but in a completely independent way.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17200
Program Title: A census of massive binaries and luminous blue variables in the Whirlpool Galaxy

Principal Investigator: El-Badry, Kareem

PI Institution: Harvard University

We propose UV and optical UVIS/WFC3 photometry of M51, a face-on Milky Way-like galaxy at d = 8.5 Mpc, in which individual luminous stars can be spatially resolved. Previous HST programs obtained 70 epochs of photometry in the red optical F606W and F814 filters, producing high-precision light curves of the 20,000 most luminous stars in the galaxy. Among these are hundreds of massive eclipsing binaries (EBs) and luminous blue variables (LBVs). These light curves are a treasure trove for studies of massive star evolution and population demographics, enabling a homogenous census of luminous star variability that would be impossible in the Milky Way. However, the existing photometry is in the Rayleigh-Jeans tail for hot stars and thus cannot constrain their temperatures and luminosities reliably. We propose 1 epoch in each of the F275W, F336W, F475W, F606W, and F814W filters (5 orbits total), enabling measurement of temperatures, radii, and luminosities for all hot stars, and masses for EBs. This program will significantly increase the utility of the existing 70 epochs of photometry, enabling a wealth of science related to massive star evolution and binary population modeling.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17201
Program Title: Determining the High-Energy Emission Mechanism in Extragalactic Jets with HST

Principal Investigator: Meyer, Eileen

PI Institution: University of Maryland Baltimore County

Bipolar jets of relativistic plasma are a well-known phenomenon associated with active galaxies, which are seen to emit high-energy radiation (optical through X-ray) on very large (kpc-Mpc) scales, requiring in-situ particle acceleration by an unknown mechanism. While the radio emission in these large-scale jets is understood to be synchrotron in origin, recent observations with HST, ALMA, and Chandra have revealed a second mysterious component at higher energies. While some optical jets have a very soft spectrum associated with the tail of the radio synchrotron component, a handful of sources have a favorable alignment such that the optical emission is very hard, indicating that it arises from the second component associated with the anomalous X-ray emission. We propose IR, optical, and UV observations of the 3 extragalactic jets known to have a very hard optical spectral index, in order to precisely measure the full IR-UV spectral shape of this rising component. The two main alternatives for the origin of the high-energy component, synchrotron and inverse Compton emission, predict different spectral slopes in the optical/UV, and these observations will allow us to conclusively determine which of these mechanisms is consistent with the data. Distinguishing the emission mechanism is critical -- the two alternatives are vastly different in terms of physical properties and implied jet powers, by orders of magnitude.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17202
Program Title: Does MWC 656 host a black hole or stripped helium star? FUV spectroscopy will tell.

Principal Investigator: El-Badry, Kareem

PI Institution: Harvard University

We propose multi-epoch STIS FUV spectroscopy of the only Be star + black hole binary candidate, MWC 656. These observations will reveal the nature of the Be star's elusive companion: a black hole, or an intermediate-mass (~3 Msun) stripped helium star. Either scenario would be extraordinary: intermediate-mass stripped stars are the main progenitors of stripped-envelope supernovae, X-ray binaries, and merging neutron stars, yet they have remained elusive for decades; the black hole would be in the mass gap and would be the only known X-ray faint high-mass X-ray binary containing a black hole. Our proposed observations will unambiguously distinguish between these two scenarios, as the UV spectrum of a massive stripped star will be very different from that of a black hole accretion disk. FUV spectra will also constrain the spectral type, mass, and RV variability of the Be star more reliably than has been possible with optical data, which are strongly contaminated by the Be star's circumstellar disk.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17203
Program Title: Towards a Comprehensive Search for Surviving Companions to Stripped-Envelope Supernovae

Principal Investigator: Fox, Ori

PI Institution: Space Telescope Science Institute

The mass-loss mechanism for stripped-envelope supernovae (SESNe) remains debated, but indirect evidence is mounting in support of binary stars. It wasn't until 2014, however, that the community obtained the first direct post-explosion detection of a surviving companion to a SESN (Type IIb SN 1993J). Since then, there have been four more, including the first fully stripped Type Ib/c SN 2013ge this past year. The field is now past the point of targeting individual systems one at a time. A statistically complete companion-mass distribution (including deep upper limits) can provide important constraints on the underlying physics used in binary evolution models (e.g., winds, rotation, metallicity, nuclear burning instabilities), which in turn has far-reaching implications in all of astrophysics, including merger sources for gravitational waves. Building the proper dataset is a slow process given the small number of viable candidates each year (considering distance, extinction, etc.). Here we propose optical+UV observations at the sites of the two most viable SESNe targets of this year to detect (or place meaningful limits on) any surviving companion. NUV (F275W/F336W) imaging offers an optimum detection strategy for the expected hot, blue stellar companions, while optical imaging can rule out shock interaction contributions and probe less likely, but possible, cooler star companions. We also propose ongoing monitoring of SN 2013ge. Given HST's time horizon, the degrading UV response on WFC3, and the requisite waiting period to allow the SN to fade before conducting a companion search, now is the time to take full advantage of HST's unique UV capabilities.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17204
Program Title: Early spectroscopy of tidal disruption events: outflow signatures or chemical composition ?

Principal Investigator: Leloudas, Giorgos

PI Institution: Technical University of Denmark-DTU Space

Tidal Disruption Events (TDEs) happen when stars get tidally disrupted by the gravitational field of a supermassive black hole. TDEs are bright panchromatic events and evolve on human-friendly time scales, which makes them prime tools to study accretion physics and black holes in all types of galaxies. Despite considerable progress achieved in the last few years, and the increasing number of TDEs discovered in the optical/UV wavelengths, we still do not know what powers the optical/UV emission of these events, with reprocessed accretion and debris stream collisions being the leading candidates. Important clues to their nature can be derived from spectroscopy, including the presence of Bowen fluorescent emission and the study of kinematical offsets. A growing number of optical TDEs show transient blueshifted line profiles, which are particularly prominent at the He + Bowen blend and at early phases. These have been interpreted as signatures of outflows, which are an inherent prediction of super-Eddington accretion models. However, the blended nature of optical lines makes it hard to disentangle outflows (measured by blueshifts) from chemical composition (the relative contributions of He II and N III). Early UV spectroscopy is required to break this degeneracy by observing the profiles of isolated He II and high-ionisation lines before maximum light, something which has never been possible to achieve before. We therefore propose a ToO program to obtain the first pre-max spectrum of a TDE in the UV and solve this outstanding question. In addition, our proposed COS-STIS observations will contribute to slowly increasing a small legacy sample of TDEs with UV spectroscopy.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17205
Program Title: Explosions in Real-Time: Rapid UV Supernova Flash Spectroscopy

Principal Investigator: Zimmerman, Erez

PI Institution: Weizmann Institute of Science

Rapid UV spectroscopy of an infant supernova explosion offers compelling science returns and can only be carried out by HST. UV spectra provide a unique insight into the first days of the explosion, a way to determine the initial metallicity and surface composition of the exploding star as well as a probe of the final year of mass loss leading to the terminal SN event, tracing the final stages of pre-explosion stellar evolution. Constraining such progenitor properties of SNe could pave the path to answer the 2020 Decadal Survey question on what powers the diversity of explosive phenomena across the elecromagnetic spectrum. This is only possible with HST in rapid ToO mode. A successful campaign to study an infant stellar explosion in the UV from its very start would benefit from preparations undertaken by STScI.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17206
Program Title: Investigating Planet Formation in the Cold Classical TNOs Through Non-Keplerian Analysis

Principal Investigator: Proudfoot, Benjamin

PI Institution: Brigham Young University

The Cold Classical Transneptunian objects (TNOs) are one of the least processed solar system subpopulations, making them a perfect place to test planet formation hypotheses. One of the most favored planetary formation models is the streaming instability, which predicts that binaries should be extremely common, especially among the Cold Classical. It also predicts that the spins of individual binary components will be well aligned with the binary orbit. Unfortunately, to date, this prediction has been difficult to test, but with increasingly long observational baselines, non-Keplerian orbital analysis is able to precisely measure both the shapes and spin poles of individual binary components. With these measurements, a quantitative test of the streaming instability model of planetesimal formation can be completed. In this program, we request 8 orbits to precisely measure the spin poles and shapes of Cold Classical TNOs, which will enable a detailed test of planet formation models.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17207
Program Title: Fundamentally More: Quadrupling the sample of CALSPEC fundamental white dwarfs

Principal Investigator: Rubin, David

PI Institution: University of Hawaii

Photometric calibration well below 1% is a requirement for many current and future programs. The best current spectrophotometric system for UV-optical-NIR calibration is CALSPEC, tied to the NTLE atmosphere models of three pure-hydrogen (DA) white dwarfs (GD 71, GD 153, G 191-B2B) that are in the Local Cavity and thus show very little interstellar extinction. STIS observations of these stars are required to match NLTE model atmospheres, on average, and with this calibration in hand, dozens of STIS-observed stars of many types have been added to CALSPEC. However, the STIS observations of the three white dwarfs do not show the same agreement with the white-dwarf atmosphere models. These differences of up to 1% translate into large differences in forecasted cosmological constraints. These particular three fundamental white dwarfs are a historical choice and other excellent DA white-dwarf calibrators could have been chosen; we identify 11 additional stars that have not already been observed with STIS spectrophotometry. Observing these new stars with STIS will thus increase by more than 4x the number of calibrator stars, providing a true statistical sample spanning temperature and gravity, and reaching a large enough sample that correlations and outliers can be found and investigated. We will compare these observations to the model atmosphere grid of Bohlin et al. 2020. With our larger sample, we will examine the residuals vs. temperature and gravity, and search for outliers. We will also examine residuals of observed minus synthetic photometry for Gaia, and Pan-STARRS. The resulting reduction and quantification of uncertainties will benefit the cosmology community.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17208
Program Title: Tick Tock, Time's Up: An Alternative to the Supermassive Black Hole Binary Scenario in J1430

Principal Investigator: Runnoe, Jessie

PI Institution: Vanderbilt University

We propose 3 orbits of optical+UV spectroscopy to test the nature of the "Tick Tock" binary supermassive black hole candidate. J143016+230344 (hereafter J1430) was recently selected based on a rapidly evolving periodicity in its multi-band photometric light curve and is predicted to coalesce within the next 3 years. J1430 is an active galactic nucleus (AGN) and its broad H-alpha line has changed from single peaked with a -2400 km/s velocity offset to double peaked at the systemic velocity. In the binary scenario, this could indicate that the broad line initially traced bulk orbital motion of the secondary and now the newly formed circumbinary broad-line region. We will test the alternative scenario that J1430 is actually a variable single AGN with a perturbed accretion disk. By nearly-simultaneously observing the Ly-alpha, CIV, H-beta, and H-alpha broad emission lines and comparing the shapes of their profiles we can discriminate between (i) bulk orbital motion of the secondary in a binary, (ii) a newly formed circumbinary broad-line region, and (iii) a single black hole with dramatic photometric variability and an emissivity enhancement like a spiral arm in the outer disk where broad lines are produced. This test will arbitrate on the binary nature of J1430.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17209
Program Title: Circumgalactic Gas on the Outskirts of the Local Group: the Halo of Sextans B

Principal Investigator: Fox, Andrew

PI Institution: Space Telescope Science Institute - ESA

Irregular galaxies are gas-rich, star-forming, and abundant. Around 40 exist in the Local Group (LG) where their gaseous halos cover large angular sizes on the sky, yet only a handful have published CGM detections. Furthermore, we have little knowledge of the CGM at the outer frontier of the Local Group at distances above 1 Mpc, where the intragroup medium is expected to be very low density so the influence of ram-pressure stripping should be small. Using archival COS observations, we have found tentative evidence for a detection of the CGM of Sextans B using a QSO sightline at low impact parameter (8 kpc or ~0.09 r_virial). We propose to confirm the CGM detection using high-S/N COS observations of a second QSO sightline at very low impact parameter from the Galaxy (4 kpc or ~0.04 r_virial). The relative strength of metal-line absorption in the two sightlines will allow us to determine the CGM mass, kinematics, and metal budget. This important experiment will allow us to place constraints on a gaseous halo in a quiescent low-density environment and explore gas flows in a previously uncharted region of the Local Group.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17210
Program Title: A Multi-Bandpass ACS Survey of Cassiopeia A: Keeping Up with its Rapidly Evolving Structure

Principal Investigator: Fesen, Robert

PI Institution: Dartmouth College

The supernova remnant Cassiopeia A (Cas A) provides the clearest look at the properties and explosion dynamics of a core-collapse supernova (CCSN). With an explosion date around 1670, Cas A is the youngest Galactic core-collapse SNR known and, at an estimated distance of 3.4 kpc, it is also among the closest and brightest. However, Cas A exhibits significant changes in its emission structure on timescales as short as 1-2 years, and large-scale changes in one or two decades, meaning that upcoming multi-wavelength investigations require nearly contemporaneous, high-resolution optical observations. This proposal describes a multi-bandpass ACS imaging program with the goals of: 1) a high-resolution optical survey that can discriminate O-Ne rich ejecta from S-Ar-Ca rich ejecta, thereby assisting new multi-wavelength studies of Cas A's ejecta and its dust content, including JWST approved Cycle 1 Near and Mid-IR observations, deep new 50 to 100 ksec Chandra high spatial resolution X-ray observations, and high spectral resolution X-ray data from the upcoming XRISM mission, 2) resolve the remnant's newly emerging and freshly reverse shocked O-Ne rich and S-Ar-Ca rich ejecta along the southern limb and north-central region, 3) add new constraints on reverse shock velocity estimates across multiple regions, and 4) measure the proper motions of the remnant's highest-velocity (8000 to 14,500 km/s) outer ejecta providing improved age and explosion center estimates plus deceleration measurements probing the density and arrangement of the local circumstellar medium as well as ejecta knot lifetimes.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17211
Program Title: Search for feedback signatures in massive blue galaxy halos

Principal Investigator: Bordoloi, Rongmon

PI Institution: North Carolina State University

The quenching of star formation creates the red sequence of galaxies, which accounts for most of the stellar mass in the Universe today. Hubble/COS studies of mainstream galaxy populations show that the Circumgalactic Medium (CGM) has some connection to quenching, as red galaxies generally have less warm halo gas than their star-forming counterparts but still exhibit substantial cold gas. This is a major conundrum: why do massive red galaxies retain a significant mass of cold gas but do not use it to form stars? We propose a systematic absorption-line experiment to answer a very well-posed question: what happens in the CGM of galaxies that are soon to quench? We have selected a sample of 20 QSO/galaxy pairs that combines 12 new QSO sightlines and six archival QSOs, all within 250 kpc projected separation of extremely blue and massive (log M*/M_sun>11) galaxies that are, or are about to be, transformed into quiescent red-sequence galaxies. New COS observations will probe the multiphase CGM using the O VI line to trace the hot gas and lower ionization species (H I, O I, C II/III, Si II/III/IV) to identify the cooler material. Combined with ground-based spectroscopic and morphological information on these massive blue galaxies, the new data will show where massive blue galaxies fit into the evolutionary sequence of galaxies and their CGM: Will their halos be full of metal-enriched gas still fueling star formation, like mainstream L* galaxies? Or has their halo gas started to fade away, driving them toward the red sequence? Our sample will apply proven techniques to an important phase of galaxy evolution where the baryon cycle has not yet been explored.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17212
Program Title: Caught in the Act: The Hierarchical Formation of Abell 1185

Principal Investigator: West, Michael

PI Institution: Lowell Observatory

Abell 1185 is a nearby example of a rich galaxy cluster still undergoing violent hierarchical assembly. Its brightest member galaxy, NGC 3550, is offset by 150 kpc from the cluster's dynamical center and is in the throes of cannibalizing several neighbors. Abell 1185 is also home to a population of intergalactic globular clusters, as well as the interacting system Arp 105, a spectacular collision between two galaxies that has spawned a compact region of intense star formation known as Ambartsumian's Knot as well as a 100-kpc-long tidal tail with embedded star clusters and newborn dwarf galaxies. Abell 1185 offers a unique opportunity to witness the ongoing birth of a dynamically young cluster and its constituents, a present-day analog to cluster formation at earlier epochs. We propose to carry out a comprehensive WFC3+ACS imaging survey of A1185 to learn more about the ongoing creation of galactic and intergalactic stellar populations in this dynamic environment. The resulting dataset will be of comparable legacy value to the ACS Treasury Survey of the Coma Cluster (GO 10861) for a fraction of the investment of time, providing a snapshot of a rich cluster environment that represents an important earlier stage in galaxy cluster evolution.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17213
Program Title: UV spectroscopy of the next interstellar object 3I

Principal Investigator: Drahus, Michal

PI Institution: Uniwersytet Jagiellonski

The discovery of the first interstellar minor bodies 1I/'Oumuamua and 2I/Borisov has opened a new era for planetary science investigations. 'Oumuamua shows that escapees from other planetary systems may significantly differ from the minor bodies that we know from our own Solar System while 2I/Borisov is similar to Solar System comets. Recognizing the importance of spectroscopic characterization in the UV, we propose a combined COS and STIS study of the yet unknown interstellar minor body 3I to quantify its gaseous emissions. Hubble is uniquely suited to this proposal given that currently it is the only facility that provides sensitive spectroscopy in UV.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17214
Program Title: Unravelling the auroral diversity and magnetospheric dynamics of Uranus while approaching solstice

Principal Investigator: Lamy, Laurent

PI Institution: Observatoire de Paris - Section de Meudon

The asymetric magnetosphere of Uranus is now approaching southern solstice, gradually shifting from its equinox-to-solstice intermediate geometry. We propose to image the UV (H and H2) aurorae of Uranus with STIS and ACS instruments near next opposition with a two-fold objective. We first aim at investigating the current, poorly known, magnetospheric configuration in which a diversity of UV aurorae, probing various acceleration mechanisms, is expected to co-exist. The observations will be carefully scheduled to sample variable solar wind conditions and all planetary longitudes to asses the solar wind/magnetosphere interaction. The aurorae will then be accurately fitted by model auroral ovals to retrieve the position of the magnetic poles. This reference will then be used, on the one hand to further constrain the inner rotation rate and the associated SIII longitude system and, on the other hand to analyze planned coordinated observations of the planet by JWST in the NIR and by XMM-Newton at X-ray wavelengths.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17215
Program Title: Asteroid Bennu Large Particle Trail

Principal Investigator: Jewitt, David

PI Institution: University of California - Los Angeles

The sporadic ejection of centimeter sized particles from Bennu was one of the major surprises from NASA's OSIRIS-REx mission and revealed this object as one of the Active Asteroids. The cause of particle ejection is not yet well established. Archival data obtained for another purpose in 2012 show evidence for an ultra-faint, narrow particle trail that likely corresponds to the summed emission from Bennu over months. We propose to image the ultra-faint particle trail from asteroid Bennu at a more favorable geometry in order to better assess the properties of the trail. Through models, we will interpret the trail parameters to determine the average particle size, ejection speed, mass loss profile and mass, in order to better constrain the mass loss process.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17216
Program Title: Establishing a 1% anchor for the Population II Distance Ladder with HST and Gaia

Principal Investigator: Savino, Alessandro

PI Institution: University of California - Berkeley

We propose to calibrate the Population II extragalactic distance ladder to a precision of 1% by acquiring HST/ACS imaging of 34 Milky Way (MW) RR Lyrae with excellent Gaia parallaxes. We will use filters commonly used for extragalactic distances (F475W, F606W, F814W) thereby eliminating uncertainties from filter transformations and zero points, which are a substantial source of systematics as recently demonstrated for Pop I distance calibration (i.e., Cepheids). From our imaging, we will construct the first empirical RR Lyrae period-Wesenheit magnitude-metallicity (PWZ) relationship in native HST filters using well-characterized MW RR Lyrae (existing excellent periods, metallicities, parallaxes) to the same precision (1%) as HST+Gaia recently established for Cepheids. With this secure PWZ, we will measure RR Lyrae distances to 23 nearby galaxies with large RR Lyrae and TRGB populations that have archival HST data in the same filters. This process will produce a new calibration of the TRGB in HST filters that is directly anchored to Gaia. These new distance calibrations will enable broad community science such as a revised Pop II measurement of the local H0 anchored to Gaia, calibrations of stellar evolution models, more robust star formation histories, and provide an anchor for JWST TRGB distances that will extend to ~50 Mpc. Gaia will continue to provide improved parallaxes, reducing our PWZ distance calibration below 1%. However, without our proposed HST observations the error floor will be limited to 2-3% due to filter transformations and zero point uncertainties, underscoring the importance of obtaining these observations now during HST's remaining lifetime.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 17217
Program Title: The First Dedicated Spectroscopic Extreme UV Survey of Low-Luminosity Broad-Line Active Galactic Nuclei

Principal Investigator: Worseck, Gabor

PI Institution: Universitat Potsdam

Characterizing the peak of the spectral energy distribution of unobscured broad-line active galactic nuclei (BLAGN) in the extreme UV is key to understand accretion onto supermassive black holes, and to calculate the budget of ionizing photons produced by BLAGN over cosmic time. While theory predicts that the peak and shape of this so-called Big Blue Bump should change with black hole mass and luminosity, existing UV composite spectra of BLAGN are either based on simplistic aggregates of archival data or just on luminous quasars. We propose the first dedicated spectroscopic survey to study the Big Blue Bump of low-luminosity BLAGN with HST/COS. Limited archival data on five mostly serendipitously observed objects reveal typical BLAGN UV continua, one of which is truncated by Lyman continuum absorption of neutral gas in the host environment. This may support limited indications from photometry that the Lyman continuum escape fraction of faint BLAGN is no longer unity. Leveraging a uniform SDSS sample of 20 low-redshift (0.27<z<0.40) low-luminosity (-21<M_1450<-20.6) BLAGN we request 20 orbits of HST/COS to (1) Characterize their average extreme UV spectrum, (2) Test predictions from AGN accretion disk models that the peak of the Big Blue Bump changes significantly within our sample that spans a range in black hole mass and Eddington ratio, and (3) Determine the average Lyman continuum escape fraction of low-luminosity BLAGN. Finding significant Lyman continuum emission in these local analogs of z>4 BLAGN discovered in recent surveys would demand an increased contribution of BLAGN to the UV background, and possibly to reionization.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17218
Program Title: The Initial Mass Function in a Low Metallicity Environment of the Milky Way

Principal Investigator: Andersen, Morten

PI Institution: European Southern Observatory - Germany

The origin of the stellar and brown dwarf Initial Mass Function (IMF) and whether it is universal are major open questions in modern astrophysics, impacting our understanding of the star formation process and interpretation of mass to light ratios of unresolved stellar populations. Of particular interest is whether the IMF changes with metallicity, especially at low metallicities, which would be conditions applicable for the early Universe. Star-forming regions near the Sun all have close to solar metallicity and are thus not useful for this experiment. The Magellanic Clouds are significantly sub-solar in metallicity, but are too distant for current telescopes and instrumentation to reach below 0.25 Msun where the Galactic field IMF peaks. Here we propose to target forming star clusters within Sh2-284, one of the most metal-poor HII regions in the outer Galaxy. WFC3's combination of high spatial resolution, efficient mosaicing possibilities and access to target water absorption bands makes it ideal to map the full area of the clusters and to derive effective temperatures for the low-mass young stellar objects (YSOs), allowing them to be placed in the HR diagram and field star contamination eliminated. With a clean sample of low-mass objects down to 50 Jupiter masses, this study will yield the most comprehensive statistics of the low-mass IMF in low-metalliicity region to date, enabling a detailed comparison with local field and solar-metallicity cluster IMFs. Our proposed observations have joint coverage with one cluster to be observed with JWST, which will enable cross calibration of YSO characterization methods between these facilities.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17219
Program Title: The evaporating atmosphere of a planet in the young bright multiplanet system AU Mic

Principal Investigator: Rockcliffe, Keighley

PI Institution: Dartmouth College

Two planets have been detected around the 23 Myr pre-main sequence M dwarf AU Mic; their known age makes them good probes for early stages of exoplanet evolution. AU Mic c is the 2.56 Earth radius outer planet orbiting with a period of 18.9 days. It has a mass of about 20 Earth masses. The planet's relatively low density, high levels of X-ray and UV radiation, proximity to its bright host, and its youth indicate this planet is likely experiencing atmospheric mass loss. This makes it an excellent target for STIS UV observations to look for escaping neutral hydrogen during transit at Lyman-alpha. AU Mic b, even closer to its host, already has similar observations, so observations of AU Mic c will provide the opportunity to explore atmospheric escape process for multiple planets in the same system. With STIS observations of AU mic c, we can constrain the planet's mass loss rate and potentially the dynamics of the upper atmosphere. Observations of AU Mic c will provide much needed additional data to test atmospheric escape models.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17220
Program Title: Are There Two Classes of Lyman-Leaky Galaxies?

Principal Investigator: Heckman, Timothy

PI Institution: The Johns Hopkins University

The largest uncertainty in understanding the Epoch of Reionization (EOR) concerns the physical processes that enable Lyman Continuum (LyC) photons to escape the ISM in EOR galaxies. In recent years there has been significant progress in finding leaky galaxies at both low ($z < 0.4$) and moderate ($z \sim 3$) redshifts. At low-z most of the known leaky galaxies are relatively low-mass galaxies hosting intense starbursts. However, there are now three examples at low-z that are dramatically different: they have relatively large stellar masses and SFRs and very compact sizes (leading extremely large values of SFR/Area). They are so disjoint in their properties from other low-z leaky galaxies that the physical processes that enable the LyC leakage are almost certainly different. Intruigingly, they are actually quite similar to known leaky galaxies at $z \sim 3$ in terms of mass and SFR. In this proposal we request time to observe five new potential members of this class of massive compact leaky starbursts, selected to have the same properties as the three currently-known examples. Our goals are to directly detect escaping LyC radiation, quantify its escape fraction, ascertain whether these galaxies show the other UV properties associated with leakiness, and improve our knowledge of their demographics. These galaxies can significantly broaden our horizons in understanding the full range of processes that enable the escape of LyC radiation. They may also represent the best local analogs to the most massive/luminous EOR galaxies, which may have been major contributors to reionization, and which will be the brightest EOR galaxies (allowing the most detailed studies with JWST).

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 17221
Program Title: Lyman alpha measurements from two mini Neptunes around one star

Principal Investigator: Zhang, Michael

PI Institution: California Institute of Technology

Multi-planet systems are ideal for studying mass loss because the two planets share the same high-energy irradiation history and similar formation histories. TOI 560c is the outer companion of TOI 560b, the first young mini Neptune with measured helium absorption from its escaping atmosphere. We propose to observe this planet with STIS/G140M to measure Lyman alpha absorption from its outflow. Atmospheric escape is especially interesting to probe in the young mini Neptune regime because it predominantly occurs in the active youth of a star's life, creating the radius gap which divides super-Earths (1--1.8 REarth) from mini-Neptunes (2--3 REarth). These observations will allow us to test recently published theoretical models of Lyman alpha absorption, in particular differentiating between different regimes of mass loss and constraining the wind launching mechanism. The TOI 560c observations, combined with existing Ly alpha and helium observations of TOI 560b, will enable a comparative study of mass loss from planets in the same system.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 17222
Program Title: WD Periastron Passage in the R Aqr System: Zooming on the New Ejecta and Jet

Principal Investigator: Karovska, Margarita

PI Institution: Smithsonian Institution Astrophysical Observatory

We propose HST observations of the R Aqr symbiotic binary system, jointly with Chandra and VLA, as a follow up on the 2020 and 2021 archival observations which show dramatic changes within 1" from the central binary resulting from the enhanced accretion during the recent periastron passage of the white dwarf (WD) accretor. These phenomena are observable in R Aqr only about twice a century, with the next periastron expected in about 40 years. Our goal is to carry out a timely high-angular resolution multi-wavelength study of this event by zooming in on the central 3" radius circumbinary region. This will allow us to determine the spatial/spectral evolution of the distribution and the characteristics of the new ejecta and jet, and to gain a unique insight into jet formation and early propagation in symbiotic and other accretion-powered systems.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 17223
Program Title: Far out in the SMC wing: the extraordinary cluster NGC 602

Principal Investigator: Zeidler, Peter

PI Institution: Space Telescope Science Institute - ESA - JWST

NGC 602 is a truly extraordinary young star cluster (YSC): located in a very low-density, low-metallicity region in the SMC Bridge it has formed a remarkable stellar content of 10^3 Solar masses and hosts many OB stars similar to Orion. Optical and infrared Hubble and Spitzer observations revealed a large number of disk-bearing, young stars in the cluster center and newly forming Young Stellar Objects embedded in the surrounding clouds. This suggests an age ladder for NGC 602 and that the massive OB stars drive star formation into the clouds. We are proposing to use the unique UV capabilities of Hubble to measure the far-ultra violet (FUV) fluxes and stellar winds of the 12 most massive cluster stars using STIS spectroscopy. Only with HST, it is possible to directly access the FUV flux budget of the entire YSC, to quantify the stellar winds for the most massive O stars. Together with scheduled Cycle 1 Webb data we will establish how efficiently NGC 602 drives star formation outwards, which may lead to an extended star formation period, and how the close proximity to the OB stars influences protoplanetary disk and planet formation and evolution. Furthermore, scheduled VLT/MUSE integral field spectroscopy will enable us to directly study how the FUV fluxes shape the surrounding gas of the HII region. NGC 602, which has a mass budget similar to Orion but is located in a sub-solar metallicity environment, provides the link between star formation and feedback processes under Milky Way conditions, where YSCs are too heavily attenuated for FUV observations, and those in lower-metallicity environments like distant galaxies, where only the most massive stars can be resolved.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 17224
Program Title: Rapid Response to Interstellar Interloper 3

Principal Investigator: Jewitt, David

PI Institution: University of California - Los Angeles

The recent detection of two interstellar interlopers (1I/Oumuamua and 2I/Borisov) in the solar system has generated enormous scientific and popular interest. Of particular surprise, in addition to the unexpected discovery of these objects, are their extreme physical differences, with 1I appearing asteroid-like and 2I being much more similar to a normal outgassing, solar system comet. These differences remain unexplained, although speculation abounds. In this proposal we request a 4 orbit disruptive ToO with WFC3 to carry out the earliest possible high resolution assessment of the next interloper object, "3I", so that more intensive follow-up observations can be rationally planned. Nucleus isolation, coma morphology assessment, and initial search for nucleus rotation, are the objectives. We request a 0 month proprietary period so the observations can be of maximum benefit to the community.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17225
Program Title: The (Ir)Regularities of Dust Attenuation in Star Forming Galaxies

Principal Investigator: Calzetti, Daniela

PI Institution: University of Massachusetts - Amherst

While dust constitutes a small fraction of a galaxy's interstellar medium, it has an outsized impact on its spectral energy distribution (SED) by reddening and attenuating the light from stars. The effects of dust are degenerate with those of the galaxy's star formation history, because stellar populations of different ages can be subject to different levels of attenuation in the presence of patchy dust. We propose to separate the variations of the ultraviolet-to-nearIR (UV-to-NIR) dust attenuation from those of the star formation history in star-forming galaxies, by leveraging the multi-wavelength and high resolution capabilities of HST. We will complement archival HST data with new ACS and WFC3 broad and narrow-band imaging to probe the SEDs of the stars and the hydrogen recombination lines of H-alpha and Pa-beta to model the spatially-resolved stellar populations, gas emission, and dust in five nearby galaxies hosting central starbursts. The five starbursts are selected based on their global far-infrared and UV emission properties, which deviate from those of typical starbursts in the local Universe, making them puzzling outliers. FUV (1600 Angstrom) to NIR (~1.6 micron) SEDs of individual star clusters and HII regions will provide necessary constraints to separate variations of stellar ages in patchy dust from variations of the shape and normalization of the dust attenuation curve. Our study will provide a benchmark for dust attenuation corrections directly applied to UV-to-NIR SEDs. This will remain the only viable option to derive physical parameters for the large high-redshift galaxy surveys produced by the JWST, Roman, Euclid, and ELTs.

Proposal Category: GO
Scientific Category: Galaxies
ID: 17226
Program Title: Characterizing Growth and Quenching Pathways of the Most Massive Galaxies at 3<z<4

Principal Investigator: Annunziatella, Marianna

PI Institution: Centro de Astrobiologia (CSIC/INTA) Inst. Nac. de Tec. Aero.

One of the biggest tensions between observations and theory lies in the existence of quiescent ultra-massive galaxies (UMGs) recently confirmed at z>3. Understanding how the star formation activity is halted is one of the most important outstanding problems in galaxy evolution, but the physics of this quenching remain uncertain. Multiple processes have been proposed with different timescales. The simultaneous measurements of star-formation histories and stellar mass density represent the most promising way to discriminate between them. However, little is known about the sizes and structures of UMGs at z>3. Recently, the largest sample to-date of UMGs (Mstar>10^11 Msun) at 3<z<4 has been spectroscopically confirmed by the MAGAZ3NE survey. The proposed program will provide deep F160W imaging for all MAGAZ3NE UMGs, enabling the measurement, for the first time, of size, structure, and central stellar mass density within 1 kpc for a representative sample of 16 spectroscopically confirmed UMGs at 3<z<4. This knowledge will inform us on the formation and quenching mechanisms, and we will investigate the connection between quenching and morphological transformation. We will constrain the pair fractions, quantifying systematic effects of blending on the number density of UMGs at 3<z<4, which provides very strong constraints on models of galaxy formation. Finally, for the quiescent UMGs (~1/2 of the sample), we will derive dynamical masses by combining size and Sersic index measurements with their stellar velocity dispersions, investigating the dynamical-to-stellar mass ratios and placing constraints on the IMF in 3<z<4 UMGs.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 17227
Program Title: Unique Constraints on the Physics of Circumgalactic Gas from Ultrahigh Resolution Observations of Galactic High-Velocity Clouds

Principal Investigator: Tripp, Todd

PI Institution: University of Massachusetts - Amherst

In recent years, theorists have been rapidly improving our understanding of the microphysics of the circumgalactic medium, but incisive observational tests of CGM theoretical developments are lagging, partly because it is observationally challenging to test models such as cloud "shattering" and non-equilibrium, rapidly cooling gas. Recently, ultrahigh spectral resolution (2.6 km/s) STIS E140H absorption spectroscopy of a QSO behind the Galactic "Outer Arm" (OA) high-velocity cloud has been published that reveals a multiphase cloud with many of the qualitative characteristics of condensing and possibly shattering gas. Moreover, the highly ionized gas in this HVC, which is kinematically aligned with lower ionization absorption, is best explained by non-equilibrium, rapidly cooling gas, and the HVC shows clear evidence of dust depletion. It has also been shown that these characteristics could not be accurately measured without the excellent spectral resolution of the E140H grating. We propose to obtain similar STIS E140H observations of AGN behind the Complex C, Complex A, and GCN HVCs to investigate whether other HVCs have similar physical characteristics. These diverse HVCs span a range of z heights, gas densities, and environmental factors, and existing lower resolution COS spectra show that a variety of lines will be detected from the HVCs, including NV. We will investigate the following questions: (1) What is the origin of the kinematically aligned highly ionized gas? (2) How do the physical conditions and time scales of the gas compare to CGM theories? (3) Do these diverse HVCs contain dust, and what are the dust depletion patterns in these environments?