HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Supermassive Black Holes and AGN

ID: 16600

Program Title: A new paradigm for Seyfert outflows and their connection to AGN feedback

Principal Investigator: Nahum Arav

PI Institution: Virginia Polytechnic Institute and State University

AGN outflows play an important role in feedback processes that control galaxy evolution and the growth of central black holes. Over the past few years a paradigm shift regarding the physical parameters and picture of Seyfert outflows has occurred. In particular, monitoring variability of the outflow absorption troughs in NGC 5548 yielded the first comprehensive,yet simple, model that can explain the physical characteristics of AGN outflows. Compared with previous analyses, the new results are different by a factor of 10 in the distance of the outflow from the central source (R), two orders of magnitude in total outflowing column density (NH), and ascribe trough variability to changes in the photoionization of a constant NH absorber, in contrast with the previous picture of changing NH. Similar results were obtained for the outflow observed in NGC 7469.

WE PROPOSE to apply this new paradigm in reanalyzing most of the large multi-epoch archival HST data of Seyfert outflows (~500ks total) to:
1) Fundamentally revise our NH, R, ionization parameter, mass flow rate and kinetic luminosity estimates in the 10 best-observed Seyfert outflows.
2) Study the newly discovered obscurer phenomenon in these objects.
3) Use the new reliable parameters to perform a comparative study of Seyfert outflows: try to determine the relationship between the velocity, distance, mass flux and energetics of the outflows to the luminosity, BH mass, Eddington ratio, and orientation of their AGN.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Supermassive Black Holes and AGN

ID: 16601

Program Title: Measuring the contribution of quasar outflows to AGN feedback

Principal Investigator: Nahum Arav

PI Institution: Virginia Polytechnic Institute and State University

There has been major progress recently in the study of quasar absorption outflows and their potential contribution for AGN feedback. HST spectral observations of the 500A-1050A rest-frame (hereafter, EUV500) in medium redshift objects (z~1) uncovered a rich phenomenology of absorption troughs. The quality and quantity of EUV500 diagnostic troughs allow us to probe the very high ionization phase, which carries 90% or more of the outflowing material, as well as determine the distance of most outflows from the central source (R). The first objective is impossible to achieve with the thousands of available ground-based spectra, and R can be measured in only ~1% of them. The EUV500 effort yielded the most energetic outflows measured to date with enough kinetic luminosity to be major agents of AGN feedback processes.

The HST spectral UV archive includes observations of more than 800 quasars. These observations were taken for studying intervening absorption systems, and quasar outflows detected in these spectra were rarely analyzed. WE PROPOSE an archive program to study the EUV500 outflows found in these spectra. Based on previous studies, we expect to find 20-30 very high ionization outflows (tripling the existing sample), and 10 -15 outflows with measurable distance (doubling the existing sample).

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR
Scientific Category: Galaxies
ID: 16602
Program Title: The LMC's Galactic Wind through the Eyes of ULLYSES

Principal Investigator: Kat Barger

PI Institution: Texas Christian University

Outflows from galaxies are known to have a significant impact on the physical processes driving star formation and the evolution of galaxies. These winds are complex, so outflows must be observed at sub-kpc scales to tie wind properties with local driving sources. The Large Magellanic Cloud offers an opportunity to resolve star-formation-driven outflows at the right scales: it is face on, lacks an AGN, and individual sources are resolved in stars, gas, and dust. We propose an Archival Legacy program to map the LMC's galactic wind (and any inflows) using high-quality STIS and COS absorption-line observations along 140 sightlines to O, B, and WR stars together with a wealth of ancillary HI, H-alpha, and O VI observations. Using the detailed profiles of absorption in multiphase diagnostic UV ions, we will (1) characterize the ionization state and kinematics of the wind, (2) measure its covering fraction, mass distribution, and outflow rate, and (3) assess the impact of the 30 Doradus starburst on the flow. We will compare the observed LMC winds with new constrained-realization simulations of the Milky Way/Magellanic system to disentangle these outflows from surrounding coronal gas. We will release high-level data products, including science-ready databases of line measurements, customized packages of ancillary data, simulated maps and spectra, and visualization tools. This large-scale, resolved census of the LMC's outflow will fill a critical gap in our knowledge of how winds work with an unprecedentedly large sample of measurements right at the scale of the driving forces, in a galaxy where all the major influences can be resolved.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Physics and Stellar Types
ID:	16603
Program Title:	Using supernova progenitors to determine the mass threshold for black hole formation

Principal Investigator:	Emma	Beasor
PI Institution:	NOIRLab - (AZ)	

There is growing consensus amongst theorists that massive stars above 20Msun should collapse immediately to black holes (BHs) with little or no visible explosion, and while empirical evidence suggests there is a lack of SN progenitors above this mass detected via pre-explosion imaging, the statistical significance of this result is weak. Here, we are proposing to analyse 6 SN that each have both pre-explosion and late-time imaging available in the archive, but which have not had their progenitor masses estimated using image subtraction techniques. By returning to the sites, we will be able to 1) confirm the disappearance of the suspected progenitor and 2) increase the accuracy of progenitor mass estimates by using the image subtraction technique. The masses estimated for each of these objects will be complimented with masses determined for 4 further SN progenitors for which we are submitting a separate GO proposal, each with pre-explosion and but which have not been followed up at late times. If these 10 progenitors all follow the same mass distribution as those already in the sample, the 20 Msun BH threshold mass will reach the statistical significance necessary (4.4 sigma) to be considered a confirmation. If however these progenitors are higher in mass, the statistical significance of the lack of progenitors above 20 Msun is weakened, and could possibly imply a higher threshold for BH formation.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	16604
Program Title:	Resolved Stellar Populations and the Multi-Wavelength Structure of Dwarf Galaxies in the Frontier Fields

Principal Investigator:	Timothy	Carleton
PI Institution:	Arizona State University	

A complete understanding of the physical processes at play as dwarf galaxies interact with dense environments is critical to a full understanding of galaxy evolution - particularly as we continue to discover new and unusual dwarf galaxies like Ultra-Diffuse Galaxies in clusters. Many processes are known to affect dwarfs in cluster environments, such as ram-pressure stripping, tidal stripping, and strangulation; however, exactly how these processes transform the structure and morphology of dwarf galaxies as they are accreted onto a cluster remains an important open question. To address this question, we propose an in-depth multi-wavelength analysis of the color gradients and integrated structural parameters of dwarf galaxies in the Hubble Frontier Fields. Measurements of the stellar-population gradient and overall structure of dwarfs, both in the cluster centers and outskirts possible with this analysis, will act as powerful tests of models describing the evolution of dwarf galaxies in clusters beyond z=0. Additionally, this analysis will provide the first constrains on the abundance and properties of nuclear star clusters beyond the local Universe - exploring a valuable new direction for understanding the formation and evolution of these objects. Precise measurements of the color gradient and integrated structure of dwarf galaxies enabled by the high-resolution images of the HST Frontier Fields will provide a fundamental understanding of the evolution of dwarf galaxies in clusters. The multi-wavelength aperture photometry and morphological catalogs produced as part of this analysis are extremely valuable for the community to fully exploit the power of the Frontier Fields.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Large Scale Structure of the Universe

ID: 16605

Program Title: HST: Hot or Cold? Improving Constraints on the Thermal Foreground of HST

Principal Investigator: Timothy Carleton

PI Institution: Arizona State University

The intensity of the near-IR extragalactic background light (EBL) is a useful measurement as astronomers strive to identify a complete census of all extragalactic objects. Significantly, direct measurements of the EBL generally arrive at intensities beyond that expected by integrated object counts from deep surveys. As these measurements have significant uncertainties, with different techniques arriving at different results, improved direct measurements of the EBL using HST have potential the potential to resolve this discrepancy and inform our understanding of the origin of any diffuse component. However, uncertainties in the level of the thermal emission contributing to HST's background substantially limit HST's ability to constrain the EBL in the near-IR. Because thermal emission is a substantial component of the background in the near-IR, the ~20% uncertainty in the level of the thermal foreground translates to a ~30% uncertainty in the EBL level in F125W and a nearly 100% uncertainty in the EBL in F160W.

We propose an archival analysis of a large number of HST's near-IR observations to constrain the thermal foreground signal as a function of orbital parameters to better than 5%, allowing measurements of the EBL using HST to achieve a similar uncertainty. This analysis will be able to:

(1) Improve constraints on the level of diffuse EBL.

(2) Allow for more precise sky subtraction for large objects.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Intergalactic Medium and the Circumgalactic
ID:	16606
Program Title:	Modeling the Mg II-Lyman Alpha Relation as a Calibrator of the Lyman Continuum Escape Fraction

Principal Investigator:	Cody Carr
PI Institution:	University of Minnesota - Twin Cities

Understanding the reionization of the universe is a major focus of upcoming ground- and space-based facilities. One major source of uncertainty is the escape of hydrogen ionizing (LyC) photons during the epoch of reionization (EoR). This quantity *cannot* be measured at z>6, so local indirect indicators are being calibrated using local galaxies. HST has invested hundreds of hours in the effort of 1) identifying LyC emitters and measuring their escape fraction of LyC radiation (fesc), and 2) calibrating indirect estimators of fesc to use at z>6. Among the various indirect tracers of fesc, Lyman alpha (Lya) and Mg II promise to be the most informative, as they carry information about the density, velocity and distribution of the neutral gas.

What is missing, and what we are proposing here, is a full modeling effort to link Mg II emission to Lya and LyC, properly accounting for the nebular emission and the continuum scattering component. Specifically, we will 1) perform detailed radiation transfer calculations of the propagation of Mg~II and Lya through the interstellar and circum-galactic media, for general geometries and velocity fields. These models will be 2) used to infer the neutral gas properties in confirmed LyC emitters identified by local Hubble surveys. In addition to interpreting Hubble data, our work will be crucial to make the most out of upcoming JWST programs that will observe EoR galaxies in Lya and MgII to estimate fesc and, ultimately, constrain the EoR.

We will make our calculations publicly available as a resource for the community to interpret JWST observations by early 2022.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Intergalactic Medium and the Circumgalactic
ID:	16607
Program Title:	Is There a Relationship Between the Metallicity of the Circumgalactic Medium and the Galaxy Orientation?

Principal Investigator:	Jane	Charlton
PI Institution:	The Pennsylvania State University	

The circumgalactic medium (CGM) of a galaxy is shaped through inflows of pristine and recycled material and by outflows from starburst and AGN activity. Theoretical expectations are for metallicities in galaxy halos to be higher along the minor axis than along the major axis. However, previous studies have failed to identify a significant trend of this type, despite some indirect suggestions that it should be there. We hypothesize that the trend is "washed out" by methods of metallicity determination that associate all of the HI with the low ionization gas. More sophisticated models have demonstrated that a typical CGM sightline passes through a complex multi-phase, multi-cloud medium, with metallicities sometimes differing by up to 1-2 orders of magnitude between different phases/clouds. We propose an archival analysis of 47 absorption line systems produced by lines of sight through the CGM of galaxies at $z<0.7$ with known impact parameters and orientations. The analysis will use the photoionization code, CLOUDY, and a cloud-by-cloud, multiphase Bayesian method to separate out the phases along the line of sight, and place formal constraints on metallicity, density, and temperature for all the different gaseous structures. This method has been demonstrated to agree with simulation data, and several of the systems have been analyzed as a proof of concept. We expect either to confirm expectations of higher metallicities along the minor axis in some of the components, or to reveal a higher level of mixing and complexity than expected. Either way it will inform the needed sub-grid physics for next generation cosmological hydrodynamic simulatons of the CGM.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16608
Program Title:	Dwarf Planet Destruction in Debris Disks

Principal Investigator:	Eugene	Chiang
PI Institution:	University of California - Berkeley	

High-resolution HST images of debris disks have revealed startling morphologies reflective of processes endemic to the pre-main-sequence, post-planet-formation era. HD 61005 and HD 32297 sport dramatically swept-back ansae likened to "Moth" wings; HD 15115 hosts a lopsided "Needle"; and AU Mic features a twisting firehose spraying dust at super-escape speeds. We will investigate how these diverse and still unexplained phenomena may stem from the same kind of underlying event: the catastrophic collisional disruption of a single potentially Vesta-class body. The collision site marks a "cascade point" where debris from the destroyed body continues to grind against the parent background disk, generating dust which if bound should occupy apsidally aligned orbits - this is the key geometric condition needed to explain Moths and Needles. In AU Mic, the cascade point provides the firehose spout from which emerges a stream of unbound dust accelerated radially and vertically by a powerful and cyclical magnetized stellar wind. We will develop the theory of how catastrophic collisions unfold in disks and synthesize new scattered-light images to compare with the HST observations. Under a unified and coherent framework, we seek to explain the perennially mysterious east-west asymmetry in HD 61005, the parallel arc in HD 32297, and the fastest moving clouds and their vertical displacements in AU Mic, as well as constrain the properties of disrupted bodies and predict disk colors for future observations.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	16609
Program Title:	Peering Through The Dust: Paschen-beta Indicators of Star Formation and Dust Attenuation
Principal Investigator:	Nikko Cleri
PI Institution:	University of Connecticut

We propose a comprehensive archival survey of attenuation-insensitive Paschen-beta star formation rates and histories, resolved line maps, and dust attenuation estimates from existing 3D-HST G141 observations of ~400 low-redshift galaxies. This large sample is made possible only by the unique combination of near-IR sensitivity and high multiplexing of the HST G141 grism. The 3D-HST survey provides the ideal dataset, augmented by CANDELS multiwavelength photometry that is among the deepest in the sky, plus public catalogs of ground-based optical spectra and H-alpha line fluxes. However, this proposal represents an entirely different experiment than the science cases of the initial 3D-HST proposal. Our study is also an effective low-redshift pathfinder for JWST Paschen-line observations of high-redshift galaxy samples observed in the near future.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16610

Program Title: Stellar Evolution Models for Multiple Stellar Populations in Globular Clusters

Principal Investigator: Aaron Dotter

PI Institution: Smithsonian Institution Astrophysical Observatory

We propose to create a set of stellar evolution and atmosphere models designed specifically for the study of multiple stellar populations in globular clusters. No such comprehensive set exists today and yet the study of multiple populations is one of the great triumphs of the Hubble Space Telescope, as well as being an active field of research.

We will compute state-of-the-art stellar models for a range of metallicities that cover the observed range of globular clusters, -2.5 < [Fe/H] < 0, with an alpha-enhanced chemical composition but also, crucially, including the light-element abundance variations that are peculiar to globular cluster stellar populations. The light-element variations will include a range of helium enhancements motivated by observational constraints as well as the enrichment of nitrogen and sodium and the depletion of carbon and oxygen. The abundance pattern will be used self-consistently in stellar evolution models and stellar atmosphere models, including synthetic spectra. The evolutionary models will include stellar masses from 0.1 to 5 solar masses, suitable for studying both the ancient globular clusters and the young globular clusters, e.g., in the Magellanic Clouds. The models will be made available in all HST photometric camera/filter systems and will be made freely available to the community in an easy-to-use format through a website that we maintain.

These stellar models will be a valuable resource for the astronomical community for years to come and will enhance the value of HST's legacy in the realm of multiple stellar populations in globular clusters.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16611
Program Title:	Modeling Spatiotemporal Systematics in Multiwavelength Stellar Photometry Catalogs

Principal Investigator:	Meredith Durbin
PI Institution:	University of Washington

The value of precision in unlocking new science has been repeatedly demonstrated across multiple fields of astrophysics (e.g., CMB cosmology and Milky Way dynamics with Gaia). Stellar photometry with the Hubble Space Telescope (HST) has progressed to the point that a similar push towards precision would reap immediate scientific benefits. Detailed and thorough characterization of HST's optical performance has resulted in unparalleled PSF photometry, but residual systematic errors currently form a barrier in achievable precision. Time-dependent changes to the telescope focus and visible sky background conspire to limit photometric precision to the ~5% level. This barrier currently prevents time-critical science including high-resolution dust mapping in nearby galaxies, and red giant branch distance measurements which are urgently needed to shed independent light on the uncomfortable tension between Cepheid- and CMB-based estimates of the local Hubble parameter.

We propose to remove this barrier by deriving corrections at the level of cataloged HST photometry, using machine learning techniques. Specifically, we will leverage archival wide-area multiwavelength data, including the PHAT survey, to model photometric biases induced by variations in the HST PSF, sky background, and other hidden effects. This model will correct resolved stellar photometry as a function of detector position, exposure date, and other telescope parameters. This methodology will be broadly applicable to photometry and cross-calibration of all existing and future space-based stellar catalogs, including HST and Roman, and will allow a new generation of critical precision stellar population studies.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16612
Program Title:	Discovery of Young Planetary Systems with Kernel-Phase Interferometry

Principal Investigator:	Samuel	Factor
PI Institution:	University of Texas at Austin	

Filling the gap between directly-imaged and RV/transiting planets will test theories of planet formation across the full range of semi-major axes, connecting formation of close to wide separation gas giants and substellar companions. Companions are notoriously hard to image near lambda/D, as coronagraphs and PSF subtraction techniques are best at >>lambda/D. Non-redundant aperture masking interferometry (NRM) can reveal companions at relevant scales, but is severely flux-limited due to the mask. Kernel-phase interferometry (KPI) applies a similar analysis to (archival) unobscured images, treating the full aperture as a grid of interfering subapertures. We have completed a new KPI pipeline for HST/NICMOS and demonstrated it for a binary survey of nearby old brown dwarfs, refining the astrometry of known companions and clarifying past marginal detections. We have also characterized the detection limits, demonstrating significant sensitivity down to flux ratios of ~10^2 at 0.5 lambda/D. If applied to HST imaging of young brown dwarfs, KPI reaches planetary-masses (~3-5 MJup) on Solar-System scales (>6 AU). We therefore propose a KPI search for planetary mass companions (PMCs) in HST/ACS imaging of 34 young BDs and low-mass stars in the young star-forming regions of Taurus and Upper Scorpius. Past (classical) image analysis was only sensitive to wide (>50 au) PMCs, but we will find companions down to ~5 au, an orbital range where young PMCs (e.g. 2M1207b) have been discovered with more classical techniques around the very nearest young BDs. We will also discover 3-5 new binary companions at tight separations which test models of binary formation and young BD evolution.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Physics and Stellar Types
ID:	16613
Program Title:	Solving the Type Ia supernova progenitor mystery with late-time light curve modeling of HST photometry

Principal Investigator:	Andrew	Fullard
PI Institution:	Michigan State University	

Type Ia supernovae (SN Ia) are explosions of white dwarfs, critical to measuring cosmological distances. Despite their importance, the precise progenitor type, specifically their pre-explosion mass, remains unknown. Early supernova light curves are powered by the 56Ni decay chain and do not disagree with progenitor models. However, at very late times (>1000 days) the supernova is mainly powered by the neutron-rich isotopes 57Ni and 55Co. The abundances of 57Ni and 55Co are strongly correlated with the central density and thus mass of the exploding white dwarf. Ergo late time observations of SNe Ia (>1000 days) have the power to discriminate between progenitor scenarios.

We propose to answer the progenitor question by enhancing the open-source TARDIS radiative transfer code with the necessary physics, and a subsequent Bayesian parameter inference of the 57Ni/55Co abundance, using the Hubble Space Telescope photometric observations of the only five SNe Ia that have been observed that late.

Specifically, we will modify TARDIS to add nuclear decay as the energy deposition source. We will extend the ionization and excitation treatment of TARDIS with additional effects. A time-dependent extension is required for the delayed energy deposition. For the 57Ni/55Co abundance inference from the photometric observations we will use machine learning-based emulators and Bayesian statistics.

Our proposal will, for the first time, combine all known important effects for modeling the late phase into one simulation, and will also use rigorous statistical parameter inference to produce firm conclusions on the decades-long outstanding progenitor problem of SNe Ia.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	16614
Program Title:	Measuring sizes of young star clusters in nearby galaxies

Principal Investigator:	Oleg	Gnedin
PI Institution:	University of Michigan	

We propose the measure the effective radii of young star clusters in nearby galaxies identified by the Legacy ExtraGalactic UV Survey (LEGUS), a Hubble Treasury Program. We have created a pipeline to accurately and robustly measure the radii of star clusters in HST imaging, and tested it using two LEGUS galaxies. We now aim to extend it to the 7200 clusters in the full LEGUS sample, more than doubling the number of clusters with published radii. With this uniformly measured sample we will describe the distribution of cluster radii and densities, more robustly determine the cluster size-mass relation, and investigate the variation of cluster properties with age and host galaxy environment. These measurements will enable an unprecedented examination of the formation and long-term evolution of star clusters.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Large Scale Structure of the Universe
ID:	16615
Program Title:	Generating HST-like Galaxy Images with Deep Neural Networks

Principal Investigator:	Shoubaneh	Hemmati
PI Institution:	California Institute of Technology	

In this proposal, we aim to train an artificial HST using Generative Adversarial Networks (GANs). Deep generative models are powerful unsupervised tools in learning true distributions of data sets. We will develop and publicly release an optimized deep learning framework using GANs which learns from the deepest HST archival galaxy images in single and multiple optical and NIR wavebands and produces HST-like observations given lower resolution ground-based images. We will quantify the confidence on the enhanced products given various combinations of input data with different qualities. This enables us to identify less represented classes of objects (if any) which could benefit from future HST observations. The enhanced images can be used by the community in various ways. Here, we mainly focus on the applications for weak lensing cosmology. With the images boosted in depth and/or resolution, we will be increasing the number of usable sources for weak lensing and will carefully quantify the gain in a) the deblending fraction, b) the photometry and c) photometric redshifts, as well as in d) the galaxy shape measurements. With these improvements, we can put tighter constraints on the cosmological parameters measurable through weak lensing.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16616
Program Title:	Interstellar tomography of highly ionized gas in the Milky Way thick disk with ULLYSES

Principal Investigator:	Jay	Howk
PI Institution:	University of Notre Dame	

The circumgalactic medium (CGM) of Milky Way-mass galaxies houses as much baryonic and metal mass as that found in the central galaxies themselves, and a majority of the CGM mass is in the form of cool/warm ionized gas (log T ~ 4-6). This ionized phase is shaped by energetic feedback from stars and AGN in both circumgalactic and interstellar gases. Understanding the physical mechanisms that dictate the conditions of this gas and drive its dynamics is critical for understanding how the evolution of galaxies is dictated by the multiphase CGM and ISM. It has become increasingly clear that the physical scale of structures in this gas is an important clue to understanding the evolution of an ionized medium, though it has been very difficult to observationally constrain the scales of CGM/ISM structures. We propose to use the ULLYSES database of STIS and COS observations to study variations in foreground Milky Way column densities of Al III, Si IV, C IV, N V, and O VI (with complementary FUSE data) between pairs of sight lines in the Small and Large Magellanic Clouds. Our analysis will include 10s, 100s, and 1000s of pairs separated by 0.01, 0.1, and 1 deg or less, probing the variation of physical scales from ~1 pc to ~3 kpc. We will assess the scale of variations at radial velocities that highlight gas in the disk, thick disk, and more distant CGM of the Milky Way and assess the scale of variations for gas having narrow b-values representing cool gas separately from gas with broad b-values representing collisionally-ionized gas. Our analysis will probe cloud sizes at the scales expected from recent theoretical models of gas fragmentation or "shattering."

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Physics and Stellar Types
ID:	16617
Program Title:	Probing The Evolution Of White-Light And FUV Flares From Low-Mass Stars With HST And TESS

Principal Investigator:	James	Jackman
PI Institution:	Arizona State University	

In recent years, studies of the habitability of terrestrial planets around low-mass stars have been incorporating the effects of far-ultraviolet (FUV) stellar flares into their analysis. The FUV flux from flares can drive the breakdown of anoxic biosignatures, while also altering atmospheric compositions. However, due to the scarcity of measured FUV flare rates for individual stars of interest, many studies rely on using empirical flare models to extrapolate white-light flare rates measured with TESS to the FUV. Such extrapolations have not been rigorously tested for low-mass stars at any age or activity, leaving open the possibility that habitability studies may currently underestimate FUV flare rates by factors of tens to hundreds.

The HST archive contains STIS and COS FUV TIME-TAG data for 89 M stars that have been, or will shortly be, observed in the short cadence mode of TESS. These stars have ages ranging from pre-main sequence to field age, and include stars associated with the 45 and 625 Myr Tuc-Hor and Hyades open clusters. We propose to combine the archival HST and TESS data of these stars to test the FUV predictions of habitability studies that rely on white-light flare rates.

We will measure the average white-light and FUV flare rates for each group of stars in our sample. By combining our white-light rates with the empirical flare models used by current habitability studies to predict FUV flare rates, we will be able to directly test their accuracy in modelling the FUV activity of low-mass stars from TESS data alone. The results of these tests will provide a vital resource for future habitability studies of terrestrial planets around low-mass stars.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Solar System Astronomy

ID: 16618

Program Title: Active Asteroid 331P/Gibbs (P/2012 F5)

Principal Investigator: David Jewitt

PI Institution: University of California - Los Angeles

331P/Gibbs (P/2012 F5) possesses one of the most detailed and best time-resolved datasets of any active asteroid, with Hubble data from 42 orbits obtained in Cycles 23, 24 and 25. These data are of high quality but remain unpublished. We propose to use these archival data to characterize 331P, with the science aim being to understand the cause of its activity. Several possible causes of mass loss in active asteroids exist, ranging from the sublimation of near surface ice, to asteroid-asteroid impact, rotational instability (driven by YORP, or by outgassing torques), thermal fracture and desiccation stresses. In 331P, both impact and rotational instability have been suggested, based on limited analyses of ground-based data. We will use the much higher resolution and better time-resolved Hubble data to test these mechanisms, while determining physical parameters including the rotation of the primary, the sizes and dust contents of the secondaries, the dust ejection speed, the time profile of the ejection and the size distribution of the ejected particles. Few active asteroids are known and fewer still have been observed in detail sufficient to determine their underlying physics. We should not miss this opportunity to examine a spectacular example of the active asteroids class.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	16619
Program Title:	Linking star formation and black hole accretion to galaxy structural properties with the HST and VLA

Principal Investigator:	Eric	Jimenez-Andrade
PI Institution:	Associated Universities, Inc.	

Deep HST observations have enabled structural analyses of high-redshift galaxies, providing key information of the mechanisms driving galaxy evolution such as star formation and the activity of supermassive black holes (SMBHs). However, UV/optical emission is often affected by dust obscuration, especially at high redshifts where dusty star-forming galaxies (SFGs) dominate the cosmic star formation rate density. To construct a complete picture of the obscured and unobscured star formation and SMBH activity of galaxies over $0.5 < z < 3$, we propose to combine archival HST ACS/WFC3 data with deep 10 GHz radio observations obtained with the Karl G. Jansky Very Large Array (VLA) toward the GOODS-N field. The resolution of this new radio map is three times better than that of current deep extragalactic surveys and matches the one of existing HST observations, allowing us to resolve the radio emission of typical SFGs out to $z=2$ on ~1.7 kpc scales. This HST/VLA data set permits detailed characterization of the rest-frame UV/optical/radio structure of ~300 high-redshift galaxies at a similar resolution, which can be used to derive spatially resolved maps of stellar mass and star formation rate across galactic disks. Using this knowledge, we will investigate (i) the contribution of dust-obscured and unobscured star formation to the stellar mass buildup in high-redshift galaxies, (ii) the UV/optical/radio size evolution of galaxies, and (iii) the mechanisms that trigger and quench star formation across cosmic time.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Physics and Stellar Types
ID:	16620
Program Title:	Galactic Archeology: Mining Globular Clusters for Massive Star Remains with Machine Learning

Principal Investigator:	Oleg Kargaltsev
PI Institution:	George Washington University

Globular clusters (GCs) contain end products of stellar evolution (neutron stars, black holes, and white dwarfs) found in X-ray binaries of various types as well as in isolation. Identifying the types of these compact objects and their binary companions, and comparing their properties with the properties of the host clusters sheds light on stellar evolution, properties of SN explosions, evolution of tight binaries, and dynamical interactions in crowded environments. Pursuing these diverse and exciting science topics requires confident classifications of large numbers of X-ray sources in GCs. Since most of these sources are faint and GCs are very crowded, the HST data are required to perform reliable matching and classifications. We propose to build upon the results of previous studies to produce a training dataset from confidently classified X-ray sources in all GCs which will include multiwavelength properties measured with HST and Chandra. We will also adopt an existing automated (machine-learning) multiwavelength classification pipeline to the GCs environments and perform classifications for all X-ray sources in 3 massive GCs with deep Chandra and milti-band, multi-epoch HST observations. In this project we will test a novel machine learning approach and verify it against the traditional classification methods. We will also perform a comprehensive census of all previously classified X-ray sources in all GCs observed by CXO and HST. The corresponding database will serve as a training dataset for the classification pipeline. The database and the classification pipeline will be released to the public to aid with classification of X-ray sources in other GCs.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	16621
Program Title:	SUPERCAL: Unified Reprocessing of the Large HST Cosmology Survey Fields - New Science, Archival Legacy, and Pathfinder for JWST

Principal Investigator:	Anton	Koekemoer
PI Institution:	Space Telescope Science Institute	

In this Archival Legacy program we propose to fully reprocess all ACS/WFC, WFC3/UVIS and WFC3/IR imaging data in the largest HST cosmology survey fields (GOODS, ECDF-S/GEMS, full COSMOS, UDS, AEGIS/EGS, HUDF/XDF and CANDELS/3D-HST) to provide a lasting value-added dataset for the community, combining over 10,000 orbits of prime and parallel imaging exposure time on these fields, in 33 filters. Many improvements in instrument calibration and processing have become available over the 19 years over which these data were obtained, with the potential to yield significant new science. We will use the latest calibrations and innovative techniques to:

(1) Create uniformly processed mosaics with significantly improved depth for all filters that have been used to observe these fields with these instruments.

(2) Improve astrometry to milliarcsecond-level accuracy, tying to Gaia-DR2 and removing current ~0.2" zonal distortions, thereby providing critical information for JWST programs that rely on this level of accuracy, as well as improved PSF alignment enabling new time-domain science.

(3) Apply a wealth of other instrumental improvements, including new CTE corrections, dark current subtraction, persistence corrections, and cosmic ray rejection improvements, all carried out unformly for this full ~10,000 orbit dataset.

We will also use these mosaics to generate a wealth of associated products, including catalogs, shapes, and related parameters, extending beyond those that are currently available to produce a legacy dataset of lasting value for current and future work in these unique fields.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Supermassive Black Holes and AGN
ID:	16622
Program Title:	Probing Feeding and Feedback in the Circumgalactic Medium of Quasars via Direct Detection of Inflows
Principal Investigator:	Marie Wingyee Lau
PI Institution:	University of California - Riverside

Cosmological hydrodynamic simulations predict galaxy mass assembly via infall from the circum- and inter-galactic medium. Infall can also occur via large scale circulations, or in association with satellite galaxies. While outflows and feedback from starbursts and quasars are extensively studied, little is known about infall, e.g. during active stages of galaxy evolution that can overlap with quasar activity. Quasar absorption lines provide unique probes of the physical properties of gas inflows and outflows in quasar host galaxies.

We propose an absorption line study of inflows in 600 quasars at $0.1 < z < 1.4$ using their high resolution HST spectra. The redshift range will probe a poorly understood cosmic epoch after the heyday of massive galaxy formation. It will also place diagnostic UV absorption lines within HST wavelength coverage, avoid severe contamination by Lya forest at higher redshifts, and allow obtaining accurate systemic redshifts via emission lines in existing ground spectra. The absorption lines covered range from CIV 1549,1550, CII 1334,1335* to OVI1031,1037, NeVIII770,780, and OIV608,609*, and will provide critical constraints on absorber kinematics, ionization levels, column densities, chemical abundances, and in some cases densities and locations. Abundance constraints are particularly important to distinguish between primordial infall and fountains already enriched inside galaxies. We will also compare the incidence and physical properties of the inflows to the more commonly measured outflows. Our goals are to understand the nature and origins of the infall systems, including their relationships to outflows, quasar feedback, and galaxy assembly.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	16623
Program Title:	Feasting on the Riches of Odysseus' Voyage

Principal Investigator:	Claus Leitherer
PI Institution:	Space Telescope Science Institute

We propose a major transformation of the evolutionary synthesis code Starburst99 to meet the needs of the community in the coming decade. A new generation of stellar evolution models optimized for (but not limited to) massive stars has been developed. These models account for the latest progress in nuclear physics, convective processes, differential rotation, and mass loss. They cover the full abundance range from super-solar to metal-free. At the same time, we made enormous strides in exploring the stellar surfaces. The HST ULLYSES program provides the most complete and highest quality ultraviolet spectral library of hot, massive stars. In conjunction with ancillary optical-near-infrared spectra obtained at ESO/VLT and state-of-the-art non-LTE, blanketed, spherical atmospheres, a new generation of stellar-population models can be developed with the synthesis code Starburst99. These models will allow us to understand the processes in star-forming galaxies in the local universe studied, e.g., by the HST Treasury program CLASSY, as well as in galaxies close to the epoch of reionization discovered by JWST. Specific questions to be addressed include (i) quantifying the effects of dust attenuation on the spectral energy distribution, (ii) probing galaxy-scale outflows by providing stellar spectral templates, (iii) providing models for the hardness of the ionizing radiation fields, (iv) exploring the shape of the uppermost stellar initial mass function, and (v) detecting shortcomings in stellar models. We will also convert the current Starburst99 Unix Solaris code into a Linux compatible distribution and migrate the software and the interface to a new, user-friendly platform.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16624
Program Title:	Simulating clustered star formation in a cosmological galactic context

Principal Investigator:	Sarah	Loebman
PI Institution:	University of California - Merced	

Over 1000 orbits of HST programs have been dedicated to characterizing clustered star formation and its connection to the full galactic environment, such as LEGUS, PHANGS-HST, and PHAT. However a key limitation in translating these HST observations into astrophysical insight is the lack of theory/simulation work that can resolve small-scale clustered star formation within realistic galactic environments, from scales of pc to 10's of kpc, all within a full cosmological context. We propose an Archival Research Theory program to generate new state-of-the-art high-dynamic range cosmological zoom-in simulations of galaxy formation and generate synthetic HST observation from them, to provide much-needed interpretations for existing HST observations. We will: (1) explore the impact of the galactic environment on clustered star formation across the full range of galactic and ISM properties; (2) examine the spatial (cross) correlation of star clusters and dense molecular gas; and (3) test how individual channels of stellar feedback impact the clusters that form and the surrounding environment. Furthermore, we will develop new tools for generating synthetic HST observations of star clusters in galaxy simulations, and we will publicly release the resulting synthetic observations and the simulation data we generate for inclusion in MAST prototypes for surveys of simulation data. These public data products will provide critical testing grounds, calibration tools, and predictions for any analysis of clustered stellar populations in nearby galaxies.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16625
Program Title:	Combining HST and Gaia to Measure Proper Motions of Distant Halo Stars: Resolving Kinematic Inhomogeneity in the Milky Way

Principal Investigator:	Kevin	McKinnon
PI Institution:	University of California - Santa Cruz	

The Milky Way's stellar halo contains information about the Galaxy's accretion history, its growth through time, and its dynamical interactions with satellites. From our location in the Galaxy, we can use measurements of individual stars to trace the history of our Galaxy's satellite accretion, measuring inhomogeneity and substructure in the kinematics and abundances in the halo caused by these interactions. To measure these properties, full positional, kinematic, and chemical abundance data is needed for halo stars along many lines of sight. Spectra can constrain distance and measure line of sight velocity and chemistry, but the tangential velocities require measuring proper motions (PMs). Precise astrometry with HST has been used to determine PMs for stars in the Milky Way halo from deep, multi-epoch data, but this is only available for a few fields. Gaia's third data release (EDR3) offers unprecedented spatial coverage by providing PMs across the whole sky, but the relatively short time baseline limits its accuracy for faint stars. Here, we propose to develop tools that will combine single-epoch HST archival images with Gaia measurements to measure more accurate PMs for many more stars at G>18 mag on many more fields in the halo. This will enhance the scientific impact of both observatories beyond their individual capabilities. Archival HST images will be matched with Gaia to increase the PM precision for faint halo stars in Gaia's catalog (18<G<21 mag). The new PMs and existing spectra will be used to measure multi-dimensional information for a large sample of halo stars. We will use this 7D data to obtain new constraints on the accretion history of our Galaxy.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	16626
Program Title:	SED Fitting in the Modern Era: Fast and Accurate Machine-Learning Assisted Software

Principal Investigator:	Desika	Narayanan
PI Institution:	University of Florida	

Recovering physical properties from galaxies via spectral energy distribution (SED) modeling is dependent on a number of assumptions, including galaxy star foramtion histories and dust attenuation curves. As we show in this proposal, uncertainties in these assumptions canpropagate to significant errors in the derived stellar masses and star formation rates of galaxies. The fundamental goal of this proposal is to minimize the uncertainties incurred by these assumptions. To accomplish this, we propose to develop a new public-facing machine-learning assisted software that maps observational photometry to the derived physical properties of galaxies. Our proposed software utilizes synthetic SEDs from cosmological hydrodynamic galaxy formation simulations as a training set, and as we demonstrate, shows significant promise in outperforming modern state-of-the-art traditional SED fitting software. We will develop our new machine learning-assisted SED fitting software to (a) enable more accurate physical property determinations from both archival and future HST observations of galaxies near and far, and (b) couple with the ETC to aid observers in planning future observations that are motivated by determining particular physical properties to below a certain error threshold.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Physics and Stellar Types
ID:	16627
Program Title:	Understanding Systematic Errors in the Cepheid Distance Scale

Principal Investigator:	Kayla	Owens
PI Institution:	University of Chicago	

The Cepheid distance scale is at the center of a controversy concerning the expansion history of the Universe. If it is to become the basis for asserting the existence of new physics, every effort must be made to fully understand the data and its calibration and application. Our program will independently reduce and optimize the resolution on all of the HST Cepheid data calibrating SNe Ia used to reach the pure Hubble flow. We need to understand at what stage in the analysis the scatter in the period-luminosity relations grows from 0.1 to 0.4 mag. in parallel with the re-reduction, we will run two experiments targetting the systematic errors in every galaxy. One experiment will target "Sky Subtraction Bias", and can can be rapidly performed. The second will generate a grid of artificial stars, from which any Cepheid light curve can be built and the systematics quantified. This will explore "Amplitude Bias" in the Cepheid discovery, and "Sigma-Clipping Bias" in the production of PL relations. The Sky Bias in the first experiment will also be cross-checked in these more realistic, but significantly more CPU-intensive studies. New variability and period finding techniques will be introduced and applied. Techniques for proactively optimising future programs aimed at high-precision and high accuracy Cepheid distances will be emphasized. New observations with HST and JWST will be suggested for retroactively maximizing the precision of previously observed extragalactic Cepheid PL relations.his program will yield the most detailed estimation of the systematic errors on the Cepheid-based Ho to date. All CMD data and all detected variable stars will be made public.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	16628
Program Title:	Establishing a New Framework for Quantifying Quenching in Low-Mass Satellite Galaxies using Gaia and HST

Principal Investigator:	Ekta Patel
PI Institution:	University of California - Berkeley

We propose to combine Gaia- and HST-based orbital histories with HST-based star formation histories (SFHs) for five classical Milky Way (MW) satellites (M* = 10^5-10^7 Msun; Carina, Fornax, Leo I, Leo II, Phoenix I) to quantify the processes by which low-mass satellites galaxies quench. Specifically, we will correlate the timing and frequency of orbital parameters (e.g., location in halo, velocity, number of orbits) with star formation episodes (bursts, dips, overall decline) to provide data-driven insight into how low-mass satellites transition from star-forming to quenched as they orbit within the halo of a massive galaxy. These five classical MW satellites have exquisite 6D phase space information (3D position + 3D velocity) from Gaia and HST, and well-populated color-magnitude diagrams (CMDs) from archival HST programs, allowing for precise SFH recovery over the past several Gyr.

In the era of precise SFHs and orbital histories, this program will establish the framework necessary to move beyond two point comparisons of infall time and quenching time commonly used in studies of low-mass galaxy quenching. Through a joint analysis of detailed SFHs and precise orbital histories, we will paint a clear picture of where, when, and how low-mass MW satellite galaxies quench. This program leverages substantial ongoing HST investments aimed at measuring SFHs and proper motions (PMs) of Local Group dwarf galaxies. The results and infrastructure established and published by this program will serve as important templates for quantifying the quenching process as more low-mass satellite galaxy SFHs and PMs are measured by HST and JWST.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Physics and Stellar Types
ID:	16629
Program Title:	Probing for astrometric accelerations in the globular cluster NGC 5139

Principal Investigator:	Imants	Platais
PI Institution:	The Johns Hopkins University	

We will probe astrometric acceleration - one of the most challenging measurement with HST. Assuming that the main source of astrometric acceleration are binaries containing the star and a dim or invisible component, there are exciting prospects as to what such a component could be. The 12-year-long and regularly-scheduled WFC3/UVIS calibration programs provide a unique opportunity to do that now. To make it even more compelling, the target of this program is the core of NGC 5139, the most enigmatic Galactic globular cluster. This project might have potential synergy with the ongoing Gaia observations, if there are common objects revealing signs of acceleration. We will also calculate new relative proper motions which are expected to have superior accuracy and helping to better characterize the internal velocity dispersion.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Physics and Stellar Types
ID:	16630
Program Title:	A New Empirical Test of Magnesium, Silicon, and Calcium NLTE Calculations Using UV Spectroscopy of Metal-Poor Stars

Principal Investigator:	Ian	Roederer
PI Institution:	University of Michigan	

The alpha elements magnesium (Mg), silicon (Si), and calcium (Ca) are of fundamental importance to a wide range of fields in astronomy, including stellar evolution, Galactic assembly, and planet formation. Questions about the reliability of their abundance measurements in cool stars remain, however. The proposed study will examine the Mg, Si, and Ca abundances from lines of both neutral and ionized species in a sample of 14 metal-poor stars to perform a new test of the reliability of current abundance methods. Mg, Si, and Ca abundances in stars are nearly always derived from lines of their neutral atoms, and the novel feature of the proposed study is in deriving their abundances based on lines of Mg+, Si+, and Ca+, which are detectable in the UV. It will empirically test non-LTE (local thermodynamic equilibrium) calculations by providing a robust benchmark abundance for them to match: the abundance derived from weak lines of the ions, which are formed in LTE. Results will be compared against approximately 10 previous NLTE calculations for Mg, Si, or Ca, and will be used to assess Galactic chemical evolution model predictions. A laboratory experiment component will anchor theoretical branching fractions for the UV Si II lines to calibrate them to an absolute experimental scale. This work will rely on archival UV spectra originally collected for other purposes, thereby enabling a new, potentially transformative application from these legacy data.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Large Scale Structure of the Universe
ID:	16631
Program Title:	A Blinded Photometric Reanalysis of the Cepheid Observations

Principal Investigator:	David	Rubin
PI Institution:	University of Hawaii	

Tension in the value of the Hubble constant (H0) between early universe measurements and late-universe (local) measurements is the largest source of controversy in cosmology today. The tension posed between the early and late universe would have profound implications for new physics---if it is confirmed. To confirm this tension, we need crosschecks and independent analyses, particularly at the (difficult and less often checked) level of photometry. We propose a pixel-level, blinded reanalysis of the WFC3 Cepheid data, which becomes severely crowed at tens of Mpc distances. Instead of resampling each dither to a common frame, we will model the original WFC3 pixels directly, thus yielding no loss of information and well-understood pixel-level uncertainties. Futuremore, we will infer a probabilistic catalog of sources around each Cepheid, which has been shown to outperform traditional techniques in crowded fields. This project, if funded, will thus be able to confirm or reject the tension between the early and late universe.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR
Scientific Category: Galaxies
ID: 16633
Program Title: Unlocking the Potential of Galactic Outflow Observations

Principal Investigator: Evan Schneider

PI Institution: University of Pittsburgh

Galactic outflows play a key role in the processes of galaxy formation and evolution. Using instruments like the Cosmic Origins Spectrograph aboard the Hubble Space Telescope, observers have spent thousands of hours gathering absorption spectra of outflows, hoping to determine how much mass, momentum, and energy galaxies eject. However, interpretation of these spectra is hampered by uncertainties related to the morphology and unknown physical state of the outflowing gas. Simulations of outflows offer a solution to this challenge, but their data must first be translated into observables - a non-trivial task, given the complicated ionization state modeling that must be done. In this proposal, we outline a plan to create open-source analysis software capable of post-processing data from almost any galaxy outflow simulation in order to produce mock spectra, which can be directly compared with observed HST/COS spectra from hundreds of sightlines. We will apply these new analysis tools to existing simulation datasets, in order to (1) determine which simulations produce outflows with physical properties that are consistent with observations; and (2) place tighter constraints on the derived physical properties of outflows from existing HST spectra. These synthetic spectra will comprise a new test to discriminate between different driving mechanisms for outflows (stellar feedback, cosmic rays, etc.). Meanwhile, comparison with simulations will decrease uncertainties in observationally-derived outflow rates. Establishing meaningful consraints on these quantities is crucial to developing a complete understanding of the processes that regulate galaxy growth.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16634
Program Title:	Sculpting Hubble's Exoplanet Legacy: A Comprehensive Uniform Dataset of Exoplanet Transmission Spectra

Principal Investigator:	David Sing
PI Institution:	The Johns Hopkins University

HST launched the field of exoplanet atmospheres, thanks in large part to it's unprecedented ability to gather high precision time series spectroscopy from the UV to near-IR. Scores of exoplanet atmospheres have been been detected, with atmospheric features found in planets ranging from Jupiter down to mini-Neptune masses. While the archive is rich with exoplanet data on more than 70 exoplanets, the full potential of this data has not even begun to be realized, as no comprehensive effort has been made to reduce and compile this eclectic set of spectra together. Unfortunately, one cannot simply download a calibrated exoplanet spectrum from the MAST archive, as time series data has not been supported by STScI in this manner. The majority of this data has been published, but typically not with the latest reduction methods and calibration issues between instruments is common which complicates using literature HST spectra for JWST analysis. This archive program fills this need, generating a complete and homogeneous set of calibrated exoplanet spectra, and their ancillary data products, to a central STScI MAST location and makes publicly available all the software tools. With a modern analysis, nearly a large program of previously discarded orbits can be used. With a homogenous database of exoplanet spectra, our program enables comparative planetology studies on a wide scale, where we can gain the maximum leverage on what the physical effects environmental factors may have on the clouds seen in the optical and molecular features observed in the infrared. This database will provide a legacy set of HST near-UV and optical exoplanet spectra, ready to be utilized for JWST.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16635
Program Title:	The First Direct Measurement of CO/H2 in Sub-Solar Metallicity Environments Using ULYSSES Data

Principal Investigator:	Kirill	Tchernyshyov
PI Institution:	University of Washington	

At sub-solar metallicities, recent estimates of the CO/H2 abundance dependence differ by almost two orders of magnitude. While this dependence has been thoroughly calibrated in the Milky Way, its empirical estimation is incredibly difficult in other environments due to the lack of high-quality UV sightlines that pierce molecular gas clouds in low-metallicity galaxies. Such absorption-line measurements allow for the direct estimation of both NH2 and NCO. The recent execution of the ULYSSES Director's Discretionary program presents a unique and singular opportunity to independently constrain XCO in the Large and Small Magellanic Clouds, whose metallicities are 1/2 and 1/5 solar, respectively. These are the only two other galaxies in which UV-absorption-line measurements of both CO and H2 column densities are possible toward multiple sources. We propose to analyze the high-quality UV spectra for 43 targets behind dense H2 regions, 21 in the LMC, and 22 in the SMC, and thus increase the number of measurements of CO and H2 column densities in sub-solar metallicity environments by nearly a factor of 10. We will carefully model the continuum and blended absorption features in the tightly grouped CO bands to derive CO column densities along each line of sight, and compare them with previously-derived H2 column densities along the same lines of sight. These measurements will provide a strong constraint on XCO that does not depend on astronomical calibration factors and will serve as a new benchmark for theories and simulations of low-metallicity molecular gas.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	16636
Program Title:	How do local environmental conditions influence the stellar cluster mass-radius relation?

Principal Investigator:	David Thilker
PI Institution:	The Johns Hopkins University

HST's resolution opened the study of stellar cluster morphology to observed populations in galaxies throughout the Local Volume and beyond. The structure of stellar clusters is expected to be intimately linked to the physical conditions of their birthplace and to their subsequent path through a host galaxy. Models have had success predicting the cluster mass-radius relation (MRR). However, getting the details right requires dedicated new work from the observational side because extragalactic samples of relevant measurements remain scant and open to improvement in mass/age estimation. There now exists droves of panchromatic HST imaging with WFC3/UVIS for representative samples of typical star-forming nearby galaxies, with the two principal efforts at relevant distances being LEGUS and PHANGS-HST. Even so, a comprehensive investigation into cluster morphology remains unrealized. We now propose such an Archival HST study, aiming to revolutionize the understanding of environmentally-driven MRR dependencies and propel the next generation of simulations with new, fine-grained constraint. Capitalizing on two Legacy surveys, we will analyze ~60,000 -70,000 clusters, probing all environments with dramatically increased statistical rigor, allowing for aggregation of samples binned on such local properties (which we have already opitmally determined). We will create and publish/release a cluster catalog with improved structural fits and (age, mass) for use by the community, and answer the most pressing open questions emerging from theoretical modeling of cluster formation and evolution.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	16637
Program Title:	Quantifying the relation between exquisitely detailed dust extinction features and molecular gas using HST and ALMA

Principal Investigator:	David	Thilker
PI Institution:	The Johns Hopkins University	

We propose an archival program to identify, catalog, and characterize the striking dust extinction features visible in HST multi-band imaging of nearby galaxies. Recent studies of the Milky Way suggest that extended, coherent filaments of dense gas form the backbone of the cold interstellar medium in galaxies. Extinction mapping with HST offers almost the only way to achieve the < 10 pc resolution needed to identify dense filamentary structures in galaxies beyond the Local Group, and by eye inspection HST imaging suggests that such features are pervasive. To test this, we will combine HST's outstanding resolution and color information with advanced image-processing / machine learning techniques to identify coherent dust features and quantify the distribution of extinction across a sample of 38 nearby galaxies with public NUV-U-B-V-I imaging. Crucially, all of our targets also have public ALMA CO imaging, though at much lower resolution than achieved by HST. This will allow us to validate the extinction mapping as a tracer of molecular gas and compare the orientation and structure of dust features to the large scale morphology of the molecular gas. We also will directly compare our observed extinction features to synthetic observations from leading theoretical simulations. Lastly, in addition to providing cutting-edge data products to the community, our program will provide a strong test of whether this new view of the Milky Way's ISM is a general feature of galaxies or restricted to specific environments like spiral arms or stellar bars.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Physics and Stellar Types
ID:	16638
Program Title:	A Full Framework for Seismology of Accreting White Dwarf Stars

Principal Investigator:	Dean	Townsley
PI Institution:	University of Alabama	

Some accreting white dwarfs (WD) show near-sinusoidal light variations on hundreds of seconds, which, due to their periods and photosphereic origin, are attributed to asteroseismic non-radial oscillations within the star. Non-radial oscillations are sensitive to the star's interior mechanical and thermal structure, hence asteroseismology offers the potential to probe aspects of the structure such as mass, radius, temperature, core temperature, extent of various compositional layers, and rotation behavior along with the star's evolution history. These objects are also subject to dwarf nova outbursts, intermittent accretion events with recurrence times of order tens of years. The resulting heating of the outer layers can shift the oscillation periods in a way that is unique to each mode and may be used to identify the modes and learn about the interior. We propose to construct a full framework for detailed modeling of the non-radial standing wave oscillation modes of accreting white dwarfs. This will involve varying white dwarf parameters like mass, accretion rate, thickness of the accreted layer, spin, and others in order to be able to infer these parameters from comparing models to measurements. This is a novel and exciting direction of WD asteroseismology and will be broadly applicable to a wide variety of both previously performed and future HST measurements of these systems.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16639
Program Title:	Wide Binary Stars in Nearby Dwarf Galaxies: A Novel Probe of Dark Matter on Subgalactic Scales

Principal Investigator:	Matthew Walker
PI Institution:	Carnegie Mellon University

The survival of widely separated binary stars within dense, low-mass dwarf galaxies depends strongly on the nature of dark matter. The standard Cold Dark Matter (CDM) model generically predicts that dwarf galaxy dark matter halos are composed of a smooth component with a centrally-divergent density "cusp", plus multitudes of self-bound subhalos, sub-subhalos, etc., down to a mass limit set by particle physics. Both smooth and clumpy components would disrupt wide binary stars, via tidal forces and perturbative encounters, respectively, leaving an imprint on the binary separation function.

We propose to apply a novel, likelihood-based analysis to detect and characterize wide binary stars (separation > 3000 A.U.) in the nearby dwarf spheroidal galaxy Ursa Minor, which was observed for this purpose in Cycle 21 (GO-13470). We will apply Bayesian techniques to detect binary stars in a probabilistic sense. Improving on standard methodology that models the two-point correlation function, we will infer the binary separation function directly from the full distribution of stellar positions and known sensitivity function. We will interpret the results in the context of wide binary formation and survival in a dense dark matter halo environment, thereby providing novel tests of star formation in extreme environments and--especially if wide binaries are detected--a potentially definitive test of the CDM paradigm.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	16640
Program Title:	Braving the Storm: Quantifying the Effects of Ram Pressure and Stellar Feedback in the Large Magellanic Cloud
Principal Investigator:	Yong Zheng
PI Institution:	University of California - Berkeley

Stellar feedback (SF) and environmental interaction, such as ram pressure (RP), are two of the most important processes that shape galaxy evolution. Despite growing computational power to resolve the SF and RP processes, there are very few observational constraints that can be used to test these simulations in the vicinity of galaxies. How is gas in a galaxy affected by RP and SF, in particular, what are the signatures at the pivotal disk-halo interface that connects a galaxy's interstellar medium (ISM) and its circumgalactic medium (CGM)? To address this question, we will conduct a detailed analysis of the ionization and kinematic structure of gas at the disk-halo interface of the Large Magellanic Cloud (LMC) with 132 ULLYSES sightlines. We will (1) calculate the strengths of RP and SF across the LMC, (2) measure column density, velocity, and velocity dispersion for a set of warm ions (logT~4-5.5 K; SiIV, CIV, OVI) that trace extraplanar gas, and (3) quantify the correlation between the extraplanar gas' properties and the strengths of RP and SF. This program will give us the first glimpse into the distinguishing effects of RP and SF on the ionization and kinematic structure of extraplanar gas in the LMC. We will also provide ionization and kinematic maps of warm gas across the LMC to the community for comparison with observations at other wavelengths.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Solar System Astronomy
ID:	16687
Program Title:	Interconnection between outgassing, fast rotation and mutual orbit in binary main-belt comet 288P

Principal Investigator:	Jessica	Agarwal
PI Institution:	Technische Universitaet Braunschweig	

The binary asteroid 288P is unusual both for its sublimation-driven activity and for its peculiar mutual orbit combining similarly-sized components with a wide separation and high eccentricity. The second half if 2022 will witness the 288P system emerging from its second perihelion passage after the binary nature was discovered. We here seek to verify the possibility indicated by earlier HST observations that the mutual orbit was perturbed by an outgassing-induced torque during the 2016/17 perihelion passage. If confirmed, the activity could have led to the unusually wide semimajor axis that cannot be achieved directly from rotational fission. In addition we seek to consolidate the identity of the active component(s) to find out if the activity is a direct consequence of the splitting event leading to binary formation. We also aim to constrain the size of the largest dust particles emitted from the active component(s) that is diagnostic of the strength of sublimation and the potential role played by fast rotation in lifting the dust. Finally, we seek to understand whether the level of activity is constant between apparitions, or if a trend can be identified that would indicate the evolution of exposed ice on main belt asteroids with time.

We request five orbits of HST/WFC3 time to be scheduled at roughly 4 week intervals between August and December 2022. These data will allow us to measure the brightness and separations of the components and the evolution of dust lingering from the perihelion passage in winter 2021/22. Only HST is able to spatially resolve the components (max. separation 0.1 arcsec) and central dust cloud of this faint (V=22mag) target.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16688
Program Title:	Towards a 1% local determination of the Hubble constant: quantifying stellar association bias in the distance scale anchor galaxy NGC4258

Principal Investigator:	Richard	Anderson
PI Institution:	Ecole Polytechnique Federale de Lausanne	

The tension among recent early- and late-Universe determinations of Hubble's constant (H0) is one of the potentially most consequential open problems in astrophysics. Specifically, the present-day measurement based on a well calibrated empirical distance ladder differs by 8.3 +/- 2.0% (at 4.2 sigma) from the cosmology-dependent H0 value derived from the Planck mission's observations of the Cosmic Microwave Background. It is now crucial to demonstrate the accuracy of the distance ladder by scrutinizing even presumably small systematic errors to either resolve or intensify the tension, whereby the latter could place fundamental physics at the verge of a breakthrough.

We propose to exploit HST/WFC3's unique UV capabilities to validate and improve the late-Universe H0 measurement based on Cepheid variable stars and type-Ia supernovae (SNeIa). WFC3/UVIS F300X observations of Cepheids in the crucial anchor galaxy NGC4258 will quantify the occurrence of Cepheids in or near their natal (cluster) environments. This will allow us to improve the stellar association bias correction currently applied to the distance ladder by a) comparing clustering frequency, type, and magnitude among all distance ladder anchor galaxies (NGC4258, Milky Way, LMC); b) comparing Cepheid clustering properties between NGC4258 and the SNeIa host M101 under nearly identical observing conditions; c) increasing clustering statistics to investigate their dependence on Cepheid properties. Coordinated parallel observations of a new halo field will accurately calibrate the tip of the red giant branch (TRGB) luminosity and improve the TRGB's ability to serve as a Cepheid-independent first distance ladder rung.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Large Scale Structure of the Universe
ID:	16702
Program Title:	Cross-calibration of HST, Euclid and Roman grism/prism through WFC3-IR faint spectrophotometric white dwarf standards near the North and South Ecliptic Poles
Principal Investigator:	Philip Appleton
PI Institution:	California Institute of Technology

One of the most exciting results in modern cosmology has been the discovery of the accelerated expansion of the Universe. It could be due to an unknown energy component (i.e., dark energy) or the modification of general relativity. In order to illuminate the unknown nature of the observed cosmic acceleration, ESA's Euclid and NASA's Roman Space Telescopes will be launched in 2022 and ~2026 respectively. They will complement each other in probing cosmic acceleration with high precision and accuracy, and need tight requirements on spectrophotometry to unprecedented accuracy. Accurate absolute spectrophotometry is vital to determine the fraction of baryonic matter turned into stars, for galaxy and supernovae surveys, and to enable legacy science. Extreme care must be taken to control systematic errors and biases. We propose to establish six hot White Dwarfs as stable, spectrophotometric IR standards for use by Euclid and Roman. The targets are suitable for spectrophotometry with the WFC3-IR grisms, and chosen to lie near both ecliptic poles within the Euclid and Roman CVZ. This allows for year-round accessibility. The stars lie within two planned, frequently repeated, Euclid deep fields, and in a likely location to be observed by Roman for calibration purposes. Although not formally an HST calibration proposal, our 11-orbit program will be vital in tying Euclid/Roman deep field spectra of faint galaxies to well-calibrated HST standards. It will also cross-calibrate the spectrophometry to broad-band IR colors of these faint high ecliptic-latitude sources. This proposed program is of critical importance to the successful calibration of both Euclid and Roman.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Solar System Astronomy

ID: 16652

Program Title: Detecting Water on Metallic M-Type Asteroids in the Far-UV

Principal Investigator: Tracy Becker

PI Institution: Southwest Research Institute

The presence of hydrated minerals and/or water on asteroids has important implications for how they, and the Solar System, formed and evolved. Techniques that unambiguously detect water on asteroids can be used to identify targets for exploration and in-situ resource utilization (ISRU) and could be used to better understand how water was delivered to Earth. Asteroid hydration is typically determined through detections of the near-infrared (NIR) 3-micron absorption feature; however, interpretation of this spectral feature is complicated by the need for thermal corrections to NIR data, telluric lines in our atmosphere, and the proximity of the OH (2.8 microns) and H2O (3 microns) spectral absorption features. In the far-ultraviolet (FUV), however, water produces a strong spectral edge causing a significant difference in albedo shortward and longward of 165 nm. We propose to conduct observations of five M-type asteroids using the FUV COS G140L mode to 1) evaluate if the hydrated sub-class of the M-type asteroids are in fact hydrated or are otherwise different from the non-hydrated, presumably metallic M-types; and 2) determine if this hydration is due to OH or H2O, since only H2O is expected to produce the strong FUV spectral signature. Only three asteroids have ever been observed at wavelengths <180 nm, so this proposed program would significantly increase the database of FUV asteroid observations while also verifying if the FUV can be used to unambiguously detect water or water-bearing minerals on asteroid surfaces.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16653

Program Title: Astrometric signature of a Second Planet in Proxima

Principal Investigator: Luigi Bedin

PI Institution: Osservatorio Astronomico di Padova

Proxima Centauri is the closest star to the Sun and the closest known exo-planetary system to Earth. It is therefore a key benchmark for detailed investigations of multi-planet system architecture, particularly for low mass stars. Recent ground-based radial velocity campaigns indicate the presence of at least one --and possibly a second-- exo-planet orbiting Proxima Centauri.

To test the multi-planet configuration of this system, we propose to use HST in spatial-scanning mode to obtain the most precise relative astrometry for Proxima Centauri to date (~20 micro-arc-seconds). The proposed sequence of six (6) epochs of observations over three (3) years will unambiguously detect the astrometric perturbation of Proxima Centauri induced by the hypothesized planet c, and constrain that planet's orbital geometry and mass.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16654
Program Title:	A wide, red-giant plus non-interacting black hole binary, or triple stellar system?
Principal Investigator:	Luciana Bianchi
PI Institution:	The Johns Hopkins University

Black hole (BH) demographics in binaries is critical in view of recent results on massive stars binarity, and the proven multi-messenger detectability of compact objects mergers. Close systems are relatively simple to identify and study as the black hole accretes mass from an evolving companion, and develops an X-ray emitting accretion disk. However, identification and characterization of non-interacting BHs is elusive, but may represent a significant unstudied population.

2MASS-J05215658+4359220 is the only candidate binary presumed to harbour a non-interacting stellar-mass black hole: it consists of a red giant and an optically undetected, compact companion of about 3.3 solar masses. In the scenarios proposed so far, based on a broad ensemble of data, the origin of near-UV flux detected by GALEX and Swift remains unexplained and may be the key to understanding the system.

We propose STIS UV spectroscopy and WFC3 multi-band imaging (including UV), that uniquely will reveal the origin of the NUV flux, and hence provide a decisive clue to the nature of the system. Compatible scenarios include the presence of a white dwarf (WD) or tight WD pair or a low-mass stellar close pair orbiting the red-giant primary at a larger separation, an accretion disk, or chromospheric/TZ line emission from the red giant.
The HST UV data will uniquely allow us to conclusively discern the source of the UV emission, to detect a stellar companion (or pair) or accretion disk if present, derive physical parameters, characterize the entire system also refining the red-giant parameters, and to conclusively address the BH companion scenario postulated in recent literature.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16769

Program Title: The Missing Piece of the IC 10 X-1 Puzzle: What is the Mass of the Black Hole?

Principal Investigator: Breanna Binder

PI Institution: Cal Poly Pomona Foundation, Inc.

IC 10 X-1 belongs to the extremely rare class of Wolf-Rayet + black hole binary stellar system, and is a valuable laboratory for understanding massive star evolution, black hole formation, and the effects of X-ray irradiation on stellar winds - but only if we know the mass of the black hole. Black hole masses in these systems have proven notoriously difficult to measure with ground-based optical spectroscopy; only Hubble FUV spectroscopy currently capable of achieving a black hole mass measurement, as was demonstrated for the twin system NGC 300 X-1 (HST program #15999). With a well-constrained orbital period (1.45175d), full X-ray coverage with Chandra, XMM-Newton, and NuSTAR, and copious quantities of archival Gemini spectroscopy available, FUV spectroscopy that samples the binary orbital period is the only missing piece of the black hole mass-puzzle for IC 10 X-1. We request 10 orbits with COS/G140L to constrain the mass of the black hole in IC 10 X-1, which will have far-reaching consequences for understanding black formation and for constraining future evolutionary pathways (including the possibility of compact object-merger events) of massive binary stellar systems.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Solar System Astronomy
ID:	16770
Program Title:	The return of Rosetta's comet 67P/Churyumov-Gerasimenko

Principal Investigator:	Dennis	Bodewits
PI Institution:	Auburn University	

We request 4 orbits of HST STIS and COS observations of comet 67P/Churyumov-Gerasimenko (hereafter 67P) during its close approach to Earth to obtain large-scale coma measurements for direct comparison with the localized Rosetta spacecraft results. We will measure the bulk production rates (mol/s) of the main volatiles (H2O, CO2, and CO), search for extended sources of volatiles in the coma, and investigate the sulphur chemistry of 67P. HST's sensitivity and spectroscopic abilities in the Far Ultraviolet make it uniquely capable to simultaneously measure the Far-Ultraviolet atomic and molecular emission of chemically coupled or otherwise interdependent species in the 100-15,000 km of the coma (i.e. CS, S, and S2 ; CO, CO2+ and OH). Observations that can connect the results for the inner coma with that of fragment species more typically observed at scales of 1000s of km (A'Hearn 2017) are essential to interpret large surveys of chemical abundances of comets. The details of how comets formed still need to be worked out by the modellers, but we need to make sure that the inputs for those models have had observational biases removed.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Intergalactic Medium and the Circumgalactic
ID:	16680
Program Title:	The Circumgalactic Medium of a Gas-Rich Ultra Diffuse Galaxy

Principal Investigator:	David	Bowen
PI Institution:	Princeton University	

Ultra Diffuse Galaxies (UDGs) are galaxies with large effective radii but very low surface brightness. They were recently discovered in unprecedented numbers in the Coma Cluster, and are now being found in galaxy groups, and in isolation in the field. Their origin remains far from clear. In this proposal, we request time to observe a QSO that lies behind a gas rich UDG, using the COS G130M grating, in order to search for absorption lines from the interstellar and circumgalactic medium of the galaxy. The sightline to the QSO LBQS 1431+0142 passes within 11 kpc of the UDG ACG 242019, a galaxy with an HI mass of 6x10^8 solar masses, recovered recently in the ALFALFA survey from its 21 cm emission. This HI mass favors the detection of HI with a high column density in absorption towards the background QSO, which, in combination with metal lines, can be used to measure the metallicity of the CGM gas in the UDG. Such data can help constrain the origin of the galaxy. Comparison of our results with those from the population of Damped Lyman-alpha systems at higher redshift will begin to examine whether UDGs might contribute significantly to the population of QSO Absorption Line Systems in the universe.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16721
Program Title:	The Angular Momentum Architecture of Long-Period Giant Planets and Brown Dwarf Companions

Principal Investigator:	Brendan	Bowler
PI Institution:	University of Texas at Austin	

The origin of giant planets and brown dwarfs discovered with direct imaging at wide separations (>10 AU) is challenging to establish because multiple formation and migration mechanisms are possible. The goal of this program is to determine the angular momentum architecture of systems hosting imaged substellar companions to constrain their formation and evolutionary history. We propose WFC3/IR time-series observations of three substellar companions spanning 10-60 Mjup to search for rotationally modulated photometric variability. Rotation periods will be combined with projected rotational velocities (vsini values) and orbit monitoring efforts from the ground to assess the geometric alignment between the orbital angular momentum vector and both the stellar and companion spin axes. Mutual alignment would point to a disk-based origin while misalignment will indicate an alternative route or dynamical evolution. To date, only a single obliquity angle has been measured for a substellar companion; we aim to broaden this to a larger sample, paving the way for similar studies of lower-mass planets at longer wavelengths with JWST.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16667
Program Title:	The Final Frontier: HST and JWST Exploration of Galaxies Across Cosmic Epochs

Principal Investigator:	Marusa Bradac
PI Institution:	University of California - Davis

Despite the success of galaxy formation models, some questions remain largely unanswered. Chief among these: (1) how did galaxies reionize the universe (if they did)? (2) How do they evolve? (3) How do gas and metals cycle in and out of galaxies? JWST will undoubtedly help us advance galaxy formation and evolution science. However, to answer these and many other questions, deep rest-frame UV and optical data will still be required. Given JWST's limited lifetime, it is essential to obtain ancillary data crucial for its success. The JWST GTO program CANUCS (CAnadian NIRISS Unbiased Cluster Survey) aims to answer these questions by observing five galaxy clusters and ten parallel fields for 200 hours with NIRISS grisms, NIRCam imager, and NIRSpec multi-object spectrograph. However, only in conjunction with the proposed deep, high-resolution optical data will it determine: (1) Lyman-alpha observability of a sample of >1000 galaxies at z > 6 well into the reionization epoch. (2) Robustly determine star formation histories of >10,000 cosmic-noon galaxies. (3) Study metallicity gradients of >200 dwarf galaxies in a large and well-defined sample at cosmic noon. This proposal will deliver uniform and essential data using ACS F435W and F606W for the CANUCS clusters, perform a supernova search and explore extraordinary objects, including a galaxy similar to the host of supernova Refsdal and an intrinsically faint, low-mass confirmed z>7 source. This proposal will provide an extremely valuable data set for the whole community, and we waive any proprietary rights for this proposal.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Intergalactic Medium and the Circumgalactic
ID:	16703
Program Title:	Unveiling Multiphase Accretion Flows in a Sample of Truly Edge-on Galaxies

Principal Investigator:	Joseph	Burchett
PI Institution:	New Mexico State University	

We propose an HST/COS spectroscopy of 8 QSOs probing the extended major axis region of a sample of purely edge-on galaxies. Several studies probing these major axis CGM regions have shown that low-ionization absorption (Mg II) is kinematically correlated with the disk rotation, a potential signature of gas accretion fueling star formation and adding angular momentum to the disk. However, similar results for high-ionization material (O VI) show that the O VI absorption is not kinematically correlated with the disk rotation and likely traces the ambient, volume-filling hotter halo phase. Our study will be the first to simultaneously characterize the phase structure of these accreting streams via absorption from low- and intermediate-ionization species. We have a ground-based spectroscopic program underway to measure the rotation curves of all of our galaxy targets as well as spatially resolved SFRs and metallicities. We will correlate the kinematics of the detected CGM absorption in these COS data, including Si II, Si III, Si IV, C IV, and H I Ly-alpha with the galaxy rotation curves as well as the SFR/metallicities in the disk. In addition to unprecedented constraints on mid-ionization phases, our study will be the first to leverage truly edge-on galaxies in such an analysis, eliminating uncertainties associated with the galaxy inclination.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16689
Program Title:	Using STIS ultraviolet spectroscopy to understand the physical properties, evolution, and structure of white dwarfs in sixteen newly discovered ultracompact binaries.
Principal Investigator:	Kevin Burdge
PI Institution:	California Institute of Technology

Here, we propose to conduct a campaign to obtain HST STIS ultraviolet spectroscopy of 15 confirmed ultracompact binary systems discovered using the Zwicky Transient Facility. These observations will be used as a sensitive tool to measure the temperature and other physical properties in these systems, and will serve as a sensitive probe of accretion.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16753
Program Title:	The radius and magnetic field structure of the smallest white dwarf

Principal Investigator:	Ilaria	Caiazzo
PI Institution:	California Institute of Technology	

The white dwarf ZTF J1901+1458 is extreme in almost every regard: it rotates every 6.94 minutes, one of the shortest periods measured for an isolated white dwarf, it is threaded by a magnetic field of almost a billion Gauss, and is the smallest white dwarf for which a radius has been measured, with a size comparable to that of the Moon. The white dwarf is so compact, that it might be gravitationally unstable and headed toward collapse. The radius's measurement, however, hinges on assumptions on the white dwarf's spectral distribution that can only be verified by ultraviolet spectroscopy. Moreover, a UV spectrum will allow a detailed modeling of the white dwarf's magnetic field strength and morphology.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Solar System Astronomy
ID:	16704
Program Title:	Are the surfaces of the large moons of Uranus modified by charged particle bombardment?

Principal Investigator:	Richard	Cartwright
PI Institution:	SETI Institute	

We propose to observe the large Uranian satellites Ariel, Umbriel, Titania, and Oberon, using the Space Telescope Imaging Spectrograph (STIS) on the Hubble Space Telescope (HST), to investigate whether their surface compositions are modified by charged particles trapped in Uranus' magnetosphere. The large Uranian moons are candidate ocean worlds, with surfaces that are rich in CO2 ice. The origin of CO2 ice on these moons is uncertain, but it could be formed by ongoing charged particle bombardment of native H2O ice and C-rich material on their surfaces. Alternatively, CO2 ice could be native to these moons and sourced from their interiors, hinting at recent geologic activity.

To investigate whether charged particles modify these four moons' surface compositions, we will collect UV spectra and conduct a series of measurements: (1) compare the near-UV (300 nm) albedos of each moon's leading and trailing hemisphere to characterize longitudinal and radial trends in charged particle irradiation; (2) measure an absorption band that spans 257 to 360 nm, attributed to trapped OH formed by charged particle irradiation of H2O ice, on each moon's leading and trailing hemisphere to characterize longitudinal and radial trends in the distribution of this feature; (3) compare the distribution of the 280-nm trapped OH band to the distribution of CO2 ice; (4) compare these new STIS spectra that would be collected over the northern hemispheres of these moons (sub-observer lat. 55 N) to archived HST/FOS spectra that were collected over their southern hemispheres (sub-observer lat. 45 S) to characterize any latitudinal trends in charged particle irradiation that might be present.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16754
Program Title:	Decoding the clouds on an irradiated inflated brown dwarf

Principal Investigator:	Sarah	Casewell
PI Institution:	University of Leicester	

We propose HST time-resolved spectroscopy of a rare, eclipsing white dwarf-brown dwarf binary. The brown dwarf in the binary is a mid-L dwarf and is irradiated by its 10,000 K white dwarf companion. The brown dwarf totally eclipses the white dwarf and the white dwarf parameters are well defined, meaning there is a directly measured radius of the brown dwarf, which is inflated compared to models of field dwarfs at the same age. As such this is the only inflated, irradiated cloudy L dwarf where atmospheric characterisation is possible, leading to insights into the processes occurring in the atmosphere.

We will obtain phase resolved spectra between 1.1 and 1.7 microns using WFC3 with the G141 set up in time-series mode.
We will combine our spectra with global circulation models and atmospheric models to:
1) Determine the effective temperature of the brown dwarf,
2) Study day-night heat redistribution in unprecedented detail
3) Determine if there are significant nightside clouds.

HST can uniquely obtain the high-precision, time-resolved, near-infrared spectroscopy required by our science goals.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Supermassive Black Holes and AGN
ID:	16705
Program Title:	Shedding light on light echoes: mapping the accretion disk and broad line region in Mrk 279
Principal Investigator:	Doron Chelouche
PI Institution:	University of Haifa

There is growing evidence that our understanding of accretion onto supermassive black holes during the quasar phase is incomplete, and that accretion disks (ADs) are larger than theoretically predicted. This has far reaching implications for accretion physics in the general astrophysical context. It further influences our understanding of the growth of supermassive black holes via accretion and mergers over cosmic times, their immediate active environs, and the potential of using quasars as standard cosmological candles. Reverberation mapping (RM) has been proven successful in studying quasar interiors, which cannot be resolved by conventional imaging techniques. Nevertheless, RM inferred AD sizes are controversial, and may be affected by non-AD emission components, such as the broad line region (BLR). Here we propose a high-cadence spectroscopic-RM campaign of Mrk279 using STIS. Data will be used to constrain moments of the transfer function (between the driving continuum signal and its echo) in addition to the lag, thereby breaking the degeneracy between competing models for the origin of continuum time-delays in the UV-to-NIR spectral range. RM of the broad emission line signal will also be pursued to constrain physical models for the BLR and test claims for a tight connection between the BLR and the AD. The proposed observations are extemely timely as HST/STIS is the only operating telescope that meets our scientific requirements, and could shed light on the theoretical uncertainties that are currently plaguing the field.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16739
Program Title:	First measurement of the super-massive black hole mass using strong gravitational lensing

Principal Investigator:	Igor	Chilingarian
PI Institution:	Smithsonian Institution Astrophysical Observatory	

We have serendipitously discovered a strong gravitational lens candidate by inspecting archival HST images collected with the WFC3/UVIS in the near-UV F225W photometric band and re-confirmed it using the archival ACS/HRC F330W image. It appears as a 120 deg arc with a radius of 0.8'' centered 0.08'' S of the nucleus of the giant early type galaxy NGC524 (d=22Mpc) that, if confirmed, makes NGC524 the most nearby strong gravitational lens. NGC524 has a supermassive black hole (SMBH) of 800 million MSun measured from stellar kinematics. However, VLBI radio observations show a point source offset by 0.1'' from the photometric center of NGC524 and its position almost exactly matches the center of the UV arc. NGC524 is the only galaxy one where the contributions of stars and a SMBH within the Einstein radius are comparable and can be separated (dark matter contribution is negligible). Unfortunately, the optical surface brightness of V=16 mag/sq.arcsec prevent the spectroscopic redshift measurement of the lensed source. In near-UV the source has 300 higher contrast than in the optical because of the old stellar population in NGC524. We propose to obtain STIS near-UV spectra of the lensed source covering the wavelengths from 1650 to 3200A and determine its redshift. This will allow us to: (a) confirm or reject the Einstein ring hypothesis; (b) if confirmed this will be the first measurement of the SMBH mass done with a principally new technique; (c) if rejected and the source turns to be a structural component of NGC524, it will become a rare example of a star forming star cluster or a tiny dwarf galaxy being tidally disrupted while approaching the SMBH sphere of influence.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16668

Program Title: Monitoring Earendel, the Lensed z~6 Star

Principal Investigator: Dan Coe

PI Institution: Space Telescope Science Institute - ESA

Three strongly magnified individual stars have been discovered in z~1 galaxies thanks to temporary boosts from microlensing. All were discovered as transient events that have since faded. Now a more persistent and distant lensed star has been discovered at z~6, named "Earendel" ("morning light"). Its extremely high magnification has persisted for 3.5 years between HST observations, consistent with microlensing simulations of this object. But HST monitoring of the z~1 stars revealed things weren't always as they seemed.

Here we propose the first repeat monitoring of Earendel in the same WFC3/IR filter, with 4 more epochs F110W imaging. These data will yield Earendel's baseline flux to better constrain its magnification, and thus luminosity and mass.

Current HST data suggest it is likely very massive > 50 M_sun. And at z~6, it is likely low metallicity < 0.2 Z_sun. Very massive low metallicity stars are extremely rare in the local group and thus hard to study locally. Such stars are the likely progenitors of ~30 M_sun black holes measured by LIGO gravitational wave detections. But models of their evolutionary tracks are highly uncertain. Remarkably, this isolated z~6 star may offer the best opportunity to pinpoint the giant branch of a low metallicity massive star. Approved JWST GO observations will constrain the star's temperature, putting a z~6 star on the H-R diagram with a luminosity (and mass) precision significantly improved by this HST proposal.

To support the various communities interested in these results, we waive any proprietary period to the data,

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16771

Program Title: Early Ultraviolet Spectroscopy of a Nearby Supernova

Principal Investigator: Scott Davis

PI Institution: University of California - Davis

We propose for an ultra-rapid, disruptive ultraviolet (UV) spectroscopic sequence of one nearby SN discovered within ~24 hours of explosion and within the TESS footprint. We will combine these observations with a rapid response, high cadence Swift UV light curve, along with a comprehensive optical+near-infrared ground-based campaign. This data set will offer an unique view of the explosive shock breakout of the SN explosion, companion star interaction, and the last phases of massive star evolution. At early times, our understanding of SN progenitors usually comes from extrapolations from the optical, where less than 1% of the light is. Only UV spectroscopy will allow us to put firm constraints on the luminosity, temperature, and metallicity of the progenitor. For core collapse SNe, the early temperature evolution can constrain the progenitor radius or extended envelope. The UV light, or the SN ejecta, can ionize the surrounding circumstellar medium (CSM) and can constrain the progenitor star's metallicity, wind speed and CSM extent. For type Ia SNe, recent very early light curve excesses point to shocking with a normal companion star, CSM interaction or an unusual nickel distribution, but models cannot reproduce UV light curves, and only spectroscopy will reveal the progenitors of these essential cosmological tools. A concurrent TESS light curve for this UV spectroscopic sequence will pinpoint the moment of explosion and act as an additional probe of CSM/companion star interaction. Very early UV spectroscopy of a nearby SN is a completely unique observation that only HST can provide, and the SN community may not have this opportunity again for the foreseeable future.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 16669
Program Title: Giant impacts on giant planets

Principal Investigator: Imke de Pater

PI Institution: University of California - Berkeley

The 2009 impact and recent superbolides on Jupiter caught the world by surprise and cast doubt on impactor flux estimates for the outer solar system. Enhanced amateur planetary imaging techniques yield high spatial resolution (enabling the 2009 impact debris field detection) and rapid frame rates (enabling impact flash detections and lightcurve measurements in 2010, 2012, 2016, 2017, 2019).

We propose a ToO program to image future impacts on Jupiter and Saturn. To remove the possibility of impact cloud non-detections, the program will be triggered only if an existing impact debris field is seen, an object on a collision course with Jupiter or Saturn is discovered, or an impact light curve is measured with an estimated total energy large enough to generate an impact cloud in a giant planet atmosphere (few 10^17 J).

HST provides the only way to image these events in the ultraviolet, providing information on aerosol altitudes and on smaller particles that are less visible to ground-based infrared observations. High-resolution imaging with proper timing (not achievable from the ground) is required for precise measurement of impact site velocity fields and impact debris optical spectra. HST observations of past impacts on Jupiter have also served as cornerstones of science investigations at other wavelengths and as vehicles for effective public outreach.

Large outer solar system impacts are governed by the same physics as in the terrestrial events that dominate the impact threat to humans. Studying the behavior of impactors of various sizes and compositions, as they enter the atmosphere at varying angles and speeds, will better quantify terrestrial impact hazards.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16722
Program Title:	An HST exclusive look at two rising stars: high-energy spectra of the two closest M dwarfs to host transiting terrestrial exoplanets

Principal Investigator:	Hannah	Diamond-Lowe
PI Institution:	Technical University of Denmark-DTU Space	

As we build towards robustly detecting and characterizing the atmospheres of terrestrial exoplanets with JWST, we cannot forget to take a close look at the low-mass stars they orbit. Complete coverage of M dwarf ultraviolet spectra are needed to determine the photochemical production rates of molecular species in terrestrial planet atmospheres, which will alert us to when disequilibrium chemistry, a sign of surface processes or even life, is present. High-energy spectra from the UV to X-ray are also needed to calculate mass loss rates from planetary atmospheres, which can explain the lack of atmospheres around highly-irradiated terrestrial worlds. LTT 1445Ab and GJ 486b are two of the most spectroscopically accessible terrestrial exoplanets we will ever find, and their M dwarf hosts are similarly at the top of their class in terms of observability. We will use the unique ultraviolet capabilities of HST, supplemented by X-ray observations, to provide complete short-wavelength spectral coverage for the stars LTT 1445A and GJ 486. Both planets, LTT 1445Ab and GJ 486b, will be observed in JWST Cycle 1 with the aim of detecting their atmospheres. If we do not take the opportunity to make UV measurements of their host stars while HST is still operational, this crucial input to understanding the atmospheres of these planets will be lost. We request 18 orbits with HST (COS and STIS) to capture complete UV spectra of LTT 1445A and GJ 486.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16681

Program Title: Advancing a decades long experiment at the Galactic center

Principal Investigator: Tuan Do

PI Institution: University of California - Los Angeles

Observations of the orbits of stars around the supermassive black hole at the center of our Galaxy have brought us new and exciting insights into the physics and astrophysics of supermassive black holes. These observations have not only provided the best evidence so far for the existence of supermassive black holes, but they have also advanced our understanding of star formation and stellar dynamics in this region. With a time baseline of over 25 years, we can perform ever more powerful experiments, the latest of which are measurements of the effect of General Relativity on the orbit of the star S0-2/S2. As astrometry becomes more precise, the discovery of our Galaxy's dark cusp of compact objects is now within reach. However, there is a fundamental limitation: the stability of the reference frame. We propose to observe the Galactic center with WFC3-IR in the next three cycles, which when combined with Gaia data will create the most accurate reference frame to date. These measurements from 2022-2024 will (1) enable the detection of a dark cusp around the black hole (2) take advantage of the unique overlap in observations between HST, Gaia (ending in 2024), JWST (beginning in 2022), and the ground to cross-calibrate instrumental systematic uncertainties to build on the legacy of astrometry with HST; (3) use HST observations to double our yearly time baseline for monitoring the near-infrared activity of Sgr A* to determine the physical origins of its recent unprecedented increase in activity.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16723
Program Title:	Resolving the dichotomy of atmospheric escape in the young planet DS Tuc A b

Principal Investigator:	Leonardo	Dos Santos
PI Institution:	University of Geneva-Department of Astronomy	

One of the biggest aims in exoplanet science is to understand how planets and their atmospheres evolve. Among the several challenges faced while inching towards this goal is the severe lack of observational constraints on the high-energy environments of young exoplanets and their early history of atmospheric escape. In particular, we do not know how well Neptune-sized and smaller planets can survive atmospheric erosion during the first billion years and retain their primary atmospheres. In this context, the recently discovered planet DS Tuc A b (45 Myr) is the best target to study atmospheric escape in the first 100 Myr in the life of a Neptune-sized exoplanet, and is likely going to become a testbed to investigate the primordial chemistry of exoplanetary atmospheres with JWST. A previous transit observation with HST suggest that this planet is currently undergoing intense hydrodynamic escape, but the result is ambiguous due to insufficient phase coverage and potential stellar activity contamination. In this program, we aim to observe two more transits, which are necessary to confirm that the feature is not spurious and to study the shape of the planet's exosphere. Either a detection or a non-detection will be crucial to interpret the evolution of exoplanetary atmospheres of this young planet and other similar worlds.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16724
Program Title:	Hydrodynamic atmospheric escape in a benchmark ultra-hot Jupiter

Principal Investigator:	Leonardo	Dos Santos
PI Institution:	University of Geneva-Department of Astronomy	

Hydrodynamic atmospheric escape is thought to be the main avenue for early evolution in exoplanets ranging from gas giants to terrestrial worlds, as shown by demographic studies resulting from the Kepler survey. However, with only three exoplanets to date that display smoking gun evidence of hydrodynamic escape, most modeling efforts to understand this process have been limited to semi-arbitrary assumptions and artificial test cases. This has a downstream effect that limits our capacity to assess if sub-Jovian planets are able to retain their volatile-rich atmospheres. While hot Jupiters are under no threat of losing significant fractions of their mass, they are the best targets to study hydrodynamic escape because they have detectable signals of exospheric metals in transmission spectroscopy. These signatures can only be observed by HST in the ultraviolet. In this program, we propose to observe the transmission spectrum of the ultra-hot Jupiter WASP -76b. We predict that this planet is losing mass at a rate 10 times larger than that of HD 209458b, and we can detect escape of Mg and Fe at more than 5-sigma confidence in high resolution. We further predict that the escaping material fills the Roche lobe of the planet and is in a state of geometric blow-off. Our results will automatically yield a precise near-UV transmission spectrum of WASP-76 b, a crucial measurement to probe opacity sources in its stratosphere and rainout of metallic species.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16755
Program Title:	From Supernova Progenitors to Ionizing Radiation - HST/COS Spectroscopy of Stripped Helium Stars

Principal Investigator:	Maria Drout
PI Institution:	University of Toronto

Binary population synthesis models predict that ~30% of massive stars will have their hydrogen envelopes removed via interaction with a binary companion. The resulting ``stripped'' helium cores are relatively long-lived, hot, compact, and emit extreme ultraviolet radiation. As a result, they represent a critical piece in our understanding of the ionizing radiation from stellar populations as well as the nature of supernova and gravitational wave progenitors. However, despite their importance and predicted ubiquity, observations have remained elusive. This is now changing. Using UV maps of the Magellanic Clouds, a sample of candidate systems has been identified. Optical spectroscopy reveals stars with temperatures in excess of 60,000 K, but luminosities intermediate between Wolf-Rayet and subdwarf stars. A lack of strong emission line features indicates their mass loss rates must be more than an order of magnitude lower than previously assumed based on extrapolations from higher luminosity stars. Here, we propose to obtain HST/COS spectra of a sample of 7 of these helium stars in the Magellanic Clouds. UV observations are necessary to measure their mass loss and wind parameters, and this sample was chosen to allow the first observational constraints of these parameters as a function of both luminosity and metallicity. Precise mass loss parameters will have a large impact on the stellar radii, ionizing radiation, and final surface composition of stripped helium stars. These HST/COS observations will therefore provide vital constraints for models of binary evolution, impacting our understanding of supernova progenitors, gravitational wave sources, and ionizing radiation.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16655
Program Title:	Betelgeuse: An Iconic and Surprising Red Supergiant

Principal Investigator:	Andrea Dupree
PI Institution:	Smithsonian Institution Astrophysical Observatory

Multiple ultraviolet spectra of the nearby red supergiant, Betelgeuse, using STIS will enable unique spatially resolved measures of photospheric and chromospheric structure and mass inflows and outflows. This follows the historic dimming of the star captured by HST/STIS in 2019-2020, and will probe the unusual atmospheric structure following the dimming event. An HST campaign of 2 cycles will be complemented by multi-frequency photometry, spectroscopy, interferometry and polarimetry at radio, infrared, and optical wavelengths in order to map surface structures and their variability, and the extended outer atmosphere over both the short (420-day) and long, secondary (2000-day) periods of this supergiant. These observations, coupled with detailed modeling and simulations. will probe the structure, dynamics, and mass loss from Betelgeuse to provide crucial insights into the atmospheric physics and wind-driving mechanisms of red supergiants.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16725
Program Title:	Dynamical Masses of the Coldest Brown Dwarfs

Principal Investigator:	Trent	Dupuy
PI Institution:	University of Edinburgh, Institute for Astronomy	

On the cusp of the JWST era, we are still lacking mass measurements for the coldest brown dwarfs, even though mass is crucial for testing substellar models. We propose a 3-year orbit monitoring program to obtain the first sample of dynamical masses at temperatures of 400-800 K. With projected separations of only 1-3 AU, our targets are among the tightest and faintest substellar visual binaries ever found, discovered at the extreme limits of existing facilities. Resolved astrometry, combined with existing parallax data, is needed to measure their orbits, and only HST can deliver the high-precision monitoring required. These systems, composed entirely of T8-Y0 dwarfs, are likely to be the only such binaries amenable to direct mass measurements within the decade.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16641
Program Title:	HST/WFC3-IR Imaging of Exceptionally Luminous Himiko/CR7-Like Galaxies at z>6

Principal Investigator:	Eiichi Egami
PI Institution:	University of Arizona

Physical processes governing the formation/evolution of high-redshift galaxies in the epoch of reionization (EoR; z>6) are still not well understood. In most cases, EoR galaxies are fuzzy faint blobs showing little internal structure, and fitting various theoretical models to spatially-integrated spectral energy distributions (SEDs) is often all that can be done. There are, however, a small number of luminous EoR galaxies, such as Himiko at z=6.595 and CR7 at z=6.601, whose exceptional brightnesses have allowed spatially-resolved studies and have revealed some fascinating details.

Although such luminous EoR galaxies are rare, the Subary/Hyper Suprime-Cam (HSC) survey has recently discovered 7 comparably bright EoR galaxies with y < 25 mag (in comparison, y=25.4 and 24.5 mag with Himiko and CR7, respectively). Here, we propose to obtain HST/WFC3 near-infrared images for these exceptionally luminous z>6 galaxies with the F105W, F125W, and F160W filters. Our goals are, (1) to identify the rest-frame UV continuum morphology, (2) to measure UV continuum spectral slopes, and (3) to compare the UV continuum morphology with those of Ly-alpha, [C II], and dust emission when possible. The obtained HST data will allow us to probe the internal structures and underlying physical processes in these remarkable high-redshift galaxies.

The targeted z>6 EoR galaxies are so bright that they will also make excellent targets for NIRSpec IFU observations, enabling us to study the internal structure and kinematics of these high-redshift galaxies in greater detail. The obtained HST data will also be essential to make effective us of precious JWST time.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16726
Program Title:	A comparative study of atmospheric escape in the brightest system of super-earths straddling the evaporation valley

Principal Investigator:	David	Ehrenreich
PI Institution:	Observatoire de Geneve	

Photo-evaporation of planetary atmospheres plays a key role in the evolution of exoplanets, carving their whole population. However, direct observations of atmospheric escape are scarce and almost non-existent in the mass range of super-Earths and mini-Neptunes, while these planets are among the most impacted by the phenomenon. A huge step forward could be made by achieving a comparative study of several super-Earths, volatile-rich or not, in a single multi-planet system: such planets would indeed experience the same evolution of the stellar X and EUV flux that are driving atmospheric escape. The perfect system for such a study has just been identified: the nearby, solar-type, and naked-eye star nu^2 Lupi hosts transiting planets spanning a remarkably large range of insolation (~100 to ~5x the insolation of Earth). TESS found the transits of the two inner planets and CHEOPS detected the transit of planet d, a volatile-rich super-Earth with an exceptional period of 107 day. These super-Earths straddle the radius gap of the "evaporation valley" and could have retained different fractions of gas and volatiles. Like for previously observed warm Neptunes, they could be enshrouded in huge comet-like exospheric clouds of escaping gas, which could have built up in the mild radiative environment. The system unique combination of proximity, brightness and favorable planet characteristics offers a fantastic opportunity to exploit HST ultraviolet capabilities to search for the hydrogen, oxygen and carbon escaping three planets in whole new mass and irradiation regimes. It is the ideal testbed for advancing both observations and theories of atmospheric evaporation of exoplanets.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Supermassive Black Holes and AGN
ID:	16756
Program Title:	Quasars with small proximity zones: gravitationally lensed or exceptionally young?

Principal Investigator:	Anna-Christina Eilers
PI Institution:	Massachusetts Institute of Technology

The existence of luminous quasars hosting supermassive black holes (SMBHs) within the first billion years of cosmic history challenges our understanding of black hole growth. However, much of our understanding relies on the assumption that the observed luminosities are intrinsic to the quasars themselves. It has long been predicted that a large fraction of high-redshift quasars should be gravitationally lensed, but to date only one lensed quasar above z>5 has been confirmed despite considerable observational efforts. We propose to search for this long sought-after population of lensed quasars with HST/ACS, targeting six objects at z~6 whose rest-frame UV spectra exhibit exceptionally small proximity zones. These quasars are excellent candidates for being gravitationally lensed objects, because the local ionizing flux implied by their small proximity zones is far below the expectation from their observed UV luminosities. We aim to apply a two-fold observing strategy using imaging both in the near-IR to search for multiple quasar images, as well as in the optical regime to target foreground lensing galaxies using the intergalactic medium as a natural long-pass filter to avoid the quasar light, in order to improve the success rate of this lensing search. In case we do not find evidence for lensing, the quasars' small proximity zones could be explained by very short UV-luminous lifetimes of less than 10,000 years, requiring either super-Eddington accretion rates or highly obscured black hole growth phases, in order to explain the concomitant SMBH growth. Thus either outcome of our proposed observations promises new insights into the formation and growth of the first SMBHs.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16671
Program Title:	Unveiling the nature of interacting supernovae or supernova impostors

Principal Investigator:	Nancy	Elias-Rosa
PI Institution:	Osservatorio Astronomico di Padova	

Some apparent supernovae (SNe) with strong circumstellar interaction are likely the explosion of very massive stars. Surprisingly, a significant fraction of these explosions is preceded by outbursts from weeks to years before. When and why outbursts herald terminal SN explosions is still unknown. Moreover, in some cases, it is not even clear whether the star has undergone a terminal SN explosion or has rather experienced an extreme, but non-terminal, eruption as a "supernova impostor''. To answer these questions, we must first obtain clear evidence that these stars have indeed undergone a core-collapse supernova explosion. We propose to use HST +WFC3 to visit the field of four of these transients after they have faded to obtain a deep, high-resolution image. This will allow us to search for (or place limits on) any surviving stellar progenitor and hence test whether these are terminal explosions or not.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16772

Program Title: They Pack a Punch: Mechanical Feedback by the Lowest-Luminosity AGNs

Principal Investigator: Michael Eracleous

PI Institution: The Pennsylvania State University

LINER nuclei, the long-lived, low-accretion-rate states of supermassive black holes, are critical for understanding the AGN phenomenon in the context of galaxy evolution. Observations have established the presence of black-hole related activity in most LINERs. But, we have also learned that the line emission on ~1" (~100 pc) scales, used for LINER classification with ground-based data, is not balanced by the radiative energy output of the nucleus alone. Another, unknown power source provides most of the power on these scales. The leading candidate is centrally-driven outflows of gas that carry at least as much power as the radiative luminosity of the AGN and produce optical emission lines through shock heating. Past HST case studies of four LINERs have spatially resolved the line-emitting regions, suggested a transition from photoionization on scales of tens of pc to shock excitation on larger scales, and allowed estimates of the kinetic power. Thus, LINERs may be signposts of feedback from the AGN onto the host galaxy. As such, they help us understand more distant, important objects. But a larger, truly representative sample, spanning a wider range of LINER AGN properties, is needed to test and generalize those results. We propose optical spectroscopy, spatially resolving ~0.1 arcsec scales, for a diverse and representative sample of 15 LINERs. We have designed an economical observing program by exploiting spectra available in the archive for a large fraction of the targets. We will carry out the first comprehensive mapping and exploration of the excitation of LINER gas using multi-dimensional line-ratio diagrams on scales of ~10 pc.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO
Scientific Category: Supermassive Black Holes and AGN
ID: 16740
Program Title: The host galaxies of the first QSOs

Principal Investigator: Emanuele Farina

PI Institution: Max Planck Institute for Astrophysics

The mere presence of hundreds of luminous quasars at cosmic dawn (redshift z>6, age of the Universe <1 Gyr) represents a puzzle to mechanisms of formation and early growth of massive black holes and galaxies. The central engine of these quasars is a black hole of ~1e9 solar masses. In the local universe, such massive black holes only reside in the most massive galaxies. Detailed optical IFU observations VLT/MUSE have indeed revealed massive and extended gaseous reservoirs fueling intense episodes of star formation in z>6 quasar hosts. At the same time, high-resolution ALMA observations unveiled highly massive and star forming galaxies. However, to date, the host starlight remain elusive at such early cosmic times, due to surface brightness and wavelength range limitations.

Here we propose to perform a survey of a sample of 9 QSOs at z>6 to image their host galaxy starlight in the rest-frame optical emission (which is a robust tracer of the stellar mass). For all these objects deep MUSE and ALMA observations shows the presence of extended gas reservoirs and dust. The ultimate goal of the project is to have direct constraints on the stellar distribution in these early active galaxies, and relate this information to the spatial distribution of gas and dust. This will allow us to investigate the interplay between star formation and the gas cycle in these systems.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16656
Program Title:	Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window, Cycle 29

Principal Investigator:	Alex	Filippenko
PI Institution:	University of California - Berkeley	

We propose to obtain a series of three early-time UV spectra of one stripped-envelope core-collapse supernova (either a normal SN Ib or a normal SN Ic, whichever type is not observed in an approved Cycle 28 program), starting well before maximum brightness. The underlying nature of these objects, from the mass-loss process stripping the envelope to the details of the explosion mechanism, remain mysterious. Connections to gamma-ray bursts and X-ray flashes further motivate this study. Many high-redshift SNe are being found in deep transient surveys, but the ability to distinguish between thermonuclear Type Ia SNe and stripped-envelope core-collapse SNe requires thorough knowledge of the latter at UV wavelengths with a low-z object. By comparing the evolution of the spectra as the photosphere recedes to deeper layers of the ejecta with our time series of spectral models, we will gain a better understanding of the explosion mechanism and the degree of mixing during the explosion. Moreover, we should be able to determine the metal content of the progenitor's outer layers with our spectral models and compare with the measured metallicity of the environment. The heterogeneity seen in stripped-envelope SNe compels us to choose a normal SN Ib or SN Ic, objects with DIFFERENT characteristics than the ones that HST has observed in previous Cycles (SNe Ic-pec, IIb, Ibn), thereby gaining further insights into this unique class of cosmic explosion. We need to seize this opportunity now, while we have access to the space UV, and indeed the UV is an HST Cycle 29 priority.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Large Scale Structure of the Universe
ID:	16690
Program Title:	Measuring the Effect of Progenitor Metallicity on Type Ia Supernova Distance Estimates

Principal Investigator:	Ryan	Foley
PI Institution:	University of California - Santa Cruz	

Despite using Type Ia supernovae (SN Ia) to precisely measure cosmological parameters, we still 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.

Previous 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. To determine the overall impact of progenitor metallicity on cosmological measurements, we must increase the sample.

The community now discovers ~20 SN Ia each year >2 weeks before peak. With the increased discovery rate of young SN, we can increase the sample of SN Ia with UV spectra near peak by 50% in a single Cycle. UV observations are critical to the understanding of SN Ia explosions and progenitors and constraining fundamental parameters such as the Hubble constant. This is our best opportunity to further our understanding of SN Ia while directly improving the utility of SN Ia for cosmology.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16727
Program Title:	A Propeller Driven by Spin-Down Energy in the Intermediate Polar FO Aquarii

Principal Investigator:	Peter	Garnavich
PI Institution:	University of Notre Dame	

White dwarfs (WD) in intermediate polars (IPs) rotate rapidly and have sufficiently high magnetic-field strengths to channel gas from an accretion disk onto their magnetic poles. The WD in FO Aquarii, the so-called ``King of the IPs,'' began spinning down in 2015 after spinning up for the preceding quarter-century. Almost immediately, it began to drop into a series of low-accretion states in the optical and X-rays, behavior that was never observed when the WD was spinning up. The power generated by the spin-down is nearly 0.5 Solar luminosities, which raises a very basic question: where is this energy deposited? We hypothesize that during FO Aqr's low states, the WD powers an outflow that removes angular momentum from the WD, causing the observed spin-down. This scenario is similar to X-ray binaries in which a magnetized neutron star, after being spun-up by accretion, develops a centrifugal barrier that drives outflows or even a jet. FO Aqr's spin-down power is sufficiently high to drive a substantial outflow, and although optical spectra of FO Aqr during its recent low state hint at the existence of this feature, ultraviolet spectra are vastly more sensitive to outflowing gas because of the presence of C IV and Si IV resonance lines. We propose HST/COS observation of FO Aqr to test for outflow/jet signatures such as P-Cygni line profiles that were not present in UV spectra taken in 1995 when the WD was spinning up.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16643
Program Title:	Mapping the escape of ionizing photons across the full ionizing continuum using high-resolution Lyman alpha and C IV observations.

Principal Investigator:	Simon	Gazagnes
PI Institution:	University of Texas at Austin	

Ly-alpha (LyA) is the strongest feature in the rest-frame far-UV emission-line spectra of galaxies and our most reliable indicator of leaking ionizing photons. However, the intergalactic medium is increasingly neutral at higher redshifts, attenuating both ionizing and LyA emission from galaxies within the epoch of reionization (EoR). Additionally, LyA provides a limited tracer of the escaping ionizing radiation as it probes the low-ionization gas properties (close to the H-ionizing edge at 912 A, 13.6 eV), while the ionizing continuum peaks at significantly higher energies (500 A or 24.6 eV). Higher-energy photons significantly contribute to reionizing the neutral hydrogen as they can each ionize 2 H atoms, nevertheless, their escape-fraction is dramatically underestimated by the standard measurement of the ionizing photon escape at 900 A.

To map the escape of ionizing photons across the full ionizing continuum for the first time, we propose to combine archival and new HST/COS G130M+G160M observations of the LyA and C IV emission profiles of 10 nearby extreme UV emission-line galaxies. LyA and C IV probe different ionization stages (low and high, respectively) of the gas, and thus different energies of ionizing photons. Therefore, these high-resolution observations will enable us to determine the column densities of the low and high ionization gas, estimate the fraction of both low- and high-energy photons escaping EoR systems, and provide reliable diagnostics from emission line features observable in the early universe, which is critical for interpreting FUV emission-line features in forthcoming spectra of high-z galaxies with JWST.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16706

Program Title: This is NUTS! A Narrow-field Ultraviolet Transient Survey

Principal Investigator: Suvi Gezari

PI Institution: University of Maryland

The Ultraviolet (UV) transient sky is one of the next frontiers in time-domain astrophysics with several space mission concepts planned for the middle of the decade. UV wavelengths are typically associated with hot phenomena, but we are focused on their use in measuring shock breakout and shock cooling from core-collapse supernovae (CCSNe) at very early times. These extreme events correspond to the shock emerging from the surface of the progenitor. If properly sampled, the UV peaks can be used to constrain properties of the progenitor stars, including the energy per unit mass of the SN ejecta and the stellar radius. No previous HST UV time-domain survey had had the right depth and cadence to detect these events. Here we propose a 30 orbit (Small) Narrow-field Ultraviolet Transient Survey (NUTS) with WFC3 UVIS (F275W and F336W), which will represent the deepest and fastest UV time-domain survey to date. We intend for this survey to serve as a ``pathfinder'' to lay the foundation for future missions, both with and without HST. The survey will reach a depth of >26 mag AB over 73 square arcmin with a cadence of 2 days over 6 epochs out to a redshift of 1.3. Coordinated observations with the deep, ground-based Subaru Hyper Supreme Cam (HSC) SN survey will allow us to pinpoint the time and location of SNe. We expect the primary result of this survey to be the discovery of 2-3 shock cooling events, approximately doubling the sample of existing events. The survey will also provide significant ancillary UV transient science, including but not limited to SN shock interaction, Type Ia non-degenerate companions, and tidal disruption events.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Large Scale Structure of the Universe
ID:	16757
Program Title:	Intracluster Light in the Frontier Fields

Principal Investigator:	Anthony	Gonzalez
PI Institution:	University of Florida	

We propose a 20 orbit WFC3/IR campaign in the environs of HST Frontier Field (HFF) clusters to obtain the most comprehensive view to date of the intracluster stellar population and total baryon content in massive galaxy clusters. Our program builds upon the existing investment in the HFFs to provide contiguous coverage out to ~3 Mpc from the cluster center. We will use these data sets to make the first determination of the total stellar content, including the intracluster light (ICL), out to >0.65 r200 for each of the HFF clusters, directly constraining the extent to which the cluster galaxy population is altered by processes leading to ICL formation, and the radii over which these process are important. We will also compare the spatial distributions of the ICL, intracluster medium, galaxies, and dark matter within the central 300 kpc to establish whether the observed low scatter in the radial gas-to-stellar ratio masks underlying small scale variations due to various processeses such as ram pressure stripping, winds, and tidal stripping. This comparison will also test the recent assertion that the ICL is a highly robust tracer of the underlying mass distribution (based on work at smaller radii), and whether the ICL can be used by future missions such as Euclid and Roman to measure cluster mass distributions. Finally, we expect to be able to detect signatures of the splashback radius in at least some of these clusters, which we will use in conjunction with weak lensing masses to measure cluster mass accretion rates. Literature results for the HFF cluster MACS J1149.5+2223 demonstrate the feasibility of this program.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO
Scientific Category: Galaxies
ID: 16644
Program Title: The ionizing output of galaxies undergoing the most extreme feedback

Principal Investigator: Matthew Hayes
PI Institution: Stockholm University

Pinning down the processes at work during the last phase-change of our universe - the epoch of reionization, EoR - remains of paramount importance. While enormous progress has been made on many fronts, we still do not know the nature of the population of objects that was responsible. Recent results suggest that the rapid conclusion of the EoR should have been driven by an ensemble of very compact star-forming galaxies. The major missing piece of this puzzle, however, is knowledge of their emergent ionizing luminosity, and how this varies with galaxy type. How Lyman continuum radiation (LyC) escapes from galaxies presents an ongoing challenge that requires empirical confrontation.

Recent surveys at low redshift, where the ionizing flux can be measured, have implicated feedback from star-formation in the emission of LyC: winds are likely necessary to clear dense gas from the ISM. However no strong conclusions can currently be drawn, due to a limited dynamic range in existing surveys. Here we propose to test this feedback-based hypothesis by stretching it to its absolute limit along one axis of the parameter space: we will observe the direct LyC output of galaxies undergoing the most extreme feedback. The proposed starbursts have star-formation densities and outflow velocities an order of magnitude higher than any currently surveyed in LyC. We expect that if there is any population that is stripping its own interstellar medium, leaving channels clear for LyC escape, then it is this one. We will use the results of this very efficient program (six galaxies in just 14 orbits) to empirically evaluate the role to similar compact starbursts in cosmic reionization.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Intergalactic Medium and the Circumgalactic
ID:	16742
Program Title:	Resolving the 3D Orientation of Galactic Disks: New Constraints on Circumgalactic Gas Flow

Principal Investigator:	Stephanie Ho
PI Institution:	Texas A & M University

The observed growth in both the size and mass of galactic disks since redshift two requires an even larger increase in the specific angular momentum of the gas accreted from the circumgalactic medium, which is the only reservoir of gas that can sustain disk star formation for 10 billion years. The rotation of inflowing circumgalactic gas is therefore central to the development of the angular momentum of stellar disks. Observing gas accretion is complicated by the galactic outflows that feedback from massive stars drive out of the galactic plane. While the position angle and axis ratio describe the projected shape of the galactic disk, this leaves an ambiguity of which side of the galaxy minor axis tips toward the observer. This ambiguity produces degenerate solutions in modeling gas flows and identifying the origin of the observed gas, because observers do not know where the gas lies along line-of-sight. We propose new WFC3/UVIS imaging observation to map the spiral structures of 11 z=0.25 galaxies with circumgalactic Mg II absorption detected in the quasar sightlines. We will determine the 3D disk orientation using rotation curves and the wrapping direction of galaxy spiral arms. The imaging sample will be combined with 3 Mg II absorbing galaxies with spiral arms detected in archival images, bringing our sample to 14 galaxies. We collected high-resolution spectra of the quasars paired with the galaxies; these spectra resolved multiple Mg II components. The 3D orientation will constrain parameters of physical models (disks, radial inflow, and conical outflow) in individual sightlines. The measured gas flow properties will provide new constraints for models of disk growth.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Intergalactic Medium and the Circumgalactic
ID:	16645
Program Title:	Spectral Imaging of O VI and Ly-alpha from a Giant Intragroup Filament

Principal Investigator:	Jay	Howk
PI Institution:	University of Notre Dame	

Streams of gas in cosmological halos are critical to galaxy evolution, as they bring matter into halos (accretion) and carry matter out (outflows). In addition, "intergalactic transfer" from satellites and group members can be important for building up the gas mass of galaxies. We have discovered a giant (>100 kpc) [O II]-emitting nebula in the group environment of a z~0.5 QSO. The filament is devoid of starlight, showing instead knots of nebular emission in HST/ACS imaging; it is coincident in redshift with a partial Lyman-limit system having 1/20 solar metallicity in HST/COS spectroscopy. The filament may be an example of intragroup gas commonly identified via HI-selected absorption studies, representing either material stripped or shed from group members or accreting with new infall. We propose an ACS/SBC imaging campaign to study the spatial distribution and intensity of O VI and Ly-alpha emission from this filament, constructing a synthetic narrow band filter through difference imaging in two ACS longpass filters. Our proposed observations will allow us for the first time to understand how the warm/hot and cool phases of circumgalactic gas are related, provide a robust measure of the cooling rate of hot material in a gaseous halo, and give unique density and mass estimates in a filament. This filament is one of the few opportunities we have to image intergalactic gas prior to the next generation of UV telescopes and will be the only case for which we have both absorption and emission line data for the same species.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16743
Program Title:	A High-accuracy, Geometric Calibration of the Tip of the Red Giant Branch in the Halo of NGC 4258
Principal Investigator:	Taylor Hoyt
PI Institution:	University of Chicago

Space-based observations are on the cusp of a near-infrared (NIR) revolution, with the imminent launch of the Webb telescope, and the planned launch of the Roman (formerly WFIRST) telescope. This program aims to bridge the gap between the current and coming eras by simultaneously providing (1) the most accurate zero-point calibration of the Tip of the Red Giant Branch (TRGB) in the ACS/WFC F606W and F814W bands to date, and (2) the first direct, geometric calibration of the TRGB zero-point in space-based near-infrared (NIR) bandpasses (all previous calibrations were indirectly calibrated). We will accomplish this in only 16 orbits, a small fraction of the HST time already invested into comparable calibrations (e.g., over 150 orbits dedicated to calibrating Cepheids in this galaxy), and at a much higher accuracy.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Large Scale Structure of the Universe
ID:	16744
Program Title:	A Mira Distance to M101: Towards a Sub-3% Hubble Constant with Miras and a NIR Candle for JWST and Roman

Principal Investigator:	Caroline	Huang
PI Institution:	Smithsonian Astrophysical Observatory	

The discrepancy between local measurements of the Hubble constant (H0) and the value inferred from observations of the CMB may be our strongest indication of physics beyond a Lambda-CDM cosmological model. Direct, distance-ladder measurements of the H0 rely primarily on Cepheids and the Tip of the Red Giant Branch (TRGB) to calibrate the luminosity of Type Ia supernovae (SN Ia). Here we propose an independent approach using Mira variables. Miras can check existing Cepheid and TRGB measurements while extending the distance ladder in the era of infrared space missions such as JWST and Roman Space Telescope, which will have difficulty discovering Cepheids. Miras are pulsating variable stars that follow tight (~0.12 mag scatter) Period-Luminosity Relations (PLRs) in the near-infrared (NIR). Short-period Miras (P < 400 d) have NIR luminosities up to 2 mag brighter than TRGB and are a ubiquitous older population that have already been used to calibrate H0 with 5% uncertainty. Long-period Miras (P > 400 d) are highly luminous and follow a different PLR from short-period Miras. We will (1) obtain a new distance measurement to this galaxy using short-period Miras, resulting in a sub-3% calibration of H0 with Miras when combined with existing Mira-SN Ia hosts; (2) discover long- period Miras with HST for the first time; (3) cross-correlate long-period variables discovered in HST with Spitzer IR observations. To do this, we propose to obtain 5 epochs of near-infrared observation in M101, to study Miras in the field of SN Ia 2011fe. Combining these with archival observations of the late-time lightcurve of SN 2011fe results in ~10 epochs of observation with a baseline of ~3000 days.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16774
Program Title:	Disk, wind, and jet coupling in a black hole X-ray transient in outburst with HST and JWST

Principal Investigator:	Robert	Hynes
PI Institution:	Louisiana State University and A & M College	

Black hole X-ray transients are binary systems in which mass is transferred from a low mass star to a stellar mass black hole through an unstable (and hence transient) accretion disk, which also powers mass loss via both disk winds and relativistic jets. The basic physics of accretion and ejection has relatively little dependence on accretor mass, and the faster characteristic timescales in the stellar mass systems thus allow more detailed studies of the phenomenology than do supermassive black holes. We will obtain a broadband 1100-10000 A HST/STIS spectrum to be coordinated with an approved JWST 5-12 micron ToO program. We will deredden the SED using the 2175 A absorption, and hence model the disk's temperature distribution. This will allow us to disentangle the jet and disk components in the optical band and properly characterize the jet's spectral shape in the IR supporting the interpretation of the JWST data. Timetagged far-UV data will allow probing the rapid UV variability (both aperiodic and quasi-periodic), and comparison with the sub-second mid-IR variability, giving a unique means to disentangle the thermally reprocessed disk emission from the jet synchrotron emission. We will also search for P Cygni signatures of the disk wind in the line-rich far-UV to test if wind and jet co-exist.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO
Scientific Category: Galaxies
ID: 16672
Program Title: Ly-alpha emission from the low-z most metal-deficient star-forming galaxies

Principal Investigator: Yuri Izotov

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 complete sample of the nine most metal-deficient (12+logO/H<7.25) compact SFGs known in the local universe, to obtain medium-resolution spectra of the Ly-alpha emission line. 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)>100A). 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 Ly-alpha profiles in those medium resolution spectra will be used to indirectly estimate the escape fraction of the Lyman continuum and will provide important insight on the ISM and radiation field of the star-forming regions. Obtaining the rest-UV spectra of these nine 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.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16745
Program Title:	Classical Novae: Galactic lithium factories?

Principal Investigator:	Luca Izzo
PI Institution:	University of Copenhagen, Niels Bohr Institute

The recent detection of the 7BeII 313.0 nm resonance doublet transition in a few novae has confirmed that 7Be is produced during the thermonuclear runaway, which is the origin of nova explosions, as predicted in the '70s. 7Be decays into 7Li with a half-life of 53.2 days, but when 7Be abundances are measured relative to calcium, the resulting amount of 7Li is 4 to 5 orders of magnitude larger than the Solar meteoritic value. This implies that novae could be the major factories of 7Li in the Milky Way. However, these yields are also larger by an order of magnitude than predicted by theoretical models. We propose a target-of-opportunity program using the STIS echelle spectrograph on-board HST aimed at measuring the amount of 7Be by using as a reference Mg II 280.0 nm, which has both an electronic structure and a ionization potential more similar to Be II than Ca II. These observations will provide an independent and accurate estimate of the nova 7Be(=7Li) yields, the 7Be evolution as it decays and the 7Be(=7Li)-yield dependence on nova type. In short, are novae the main Galactic lithium factories ?

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO
Scientific Category: Galaxies
ID: 16692
Program Title: [CII], a High-z Diagnostic Diamond in the Rough

Principal Investigator: Bethan James

PI Institution: Space Telescope Science Institute - ESA

In order to fully characterize the high-z systems probed by JWST, it is essential that we prepare a robust rest-UV diagnostic toolkit to determine their physical and chemical properties. Crucially, such diagnostics must incorporate the element that emits strongest in the UV: carbon. Despite now having a suite of CIII], HeII, OIII], and CIV UV emission lines from high-z analogue systems at our fingertips from CLASSY, we are prevented from deriving accurate diagnostics because we lack a thorough understanding of the conditions affecting carbon emission in high-z environments. One key species is missing: [CII]. Here we propose to observe the [CII] 2325A multiplet in a sample of 12 CLASSY galaxies using STIS/G230L spectroscopy, thus building on pre-existing HST/COS spectroscopy to deliver essential insight into the diagnostic utility, production, and abundance of carbon. Our carefully chosen UV-emitting sample spans a wide range of high-z properties, including low-metallicity, high SFRs, and high ionization parameters. Using this important multiplet we will (i) provide the first empirical calibration of a highly-promising UV-based metallicity diagnostic, C23/HeII; (ii) decipher the ionization structure of C in each system by harnessing all of carbon's ionization stages (C+, C2+, C3+); (iii) derive highly accurate C/O abundances that do not rely on ionization correction factors (ICF); (iv) construct ICF grids for C to enable future C/O measurements in high-z systems. This study provides the first opportunity to thoroughly explore the origin of carbon in a range of high-z environments, thus exploiting its full potential as a chemical and physical diagnostic in the JWST era.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16683
Program Title:	Radioactive Stars: Bound Remnants from White Dwarf Supernovae

Principal Investigator:	Saurabh Jha
PI Institution:	Rutgers the State University of New Jersey

Type Ia supernovae (SN Ia) have enormous importance to cosmology and astrophysics, but their progenitors and explosion mechanisms are not understood in detail. Recently, observations and theoretical models have suggested that not all thermonuclear white-dwarf supernova explosions are normal SN Ia. In particular, type Iax supernovae (SN Iax, peculiar cousins to SN Ia), are thought to be exploding white dwarfs that are not completely disrupted, leaving behind a bound remnant. We propose late-time HST WFC3 observations of three recent SN Iax to directly observe if they each harbor a bound remnant, with a radiation-driven wind. Our program is designed to discover a new category of stars, powered by radioactivity, and to show that some thermonuclear supernovae are not terminal events in the life of their progenitor white dwarfs (unlike the complete disruption thought to occur in normal SN Ia).

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Supermassive Black Holes and AGN
ID:	16728
Program Title:	Physical diagnostics of AGN feedback from the first spatially resolved UV spectra of a jet-driven AGN outflow

Principal Investigator:	Sean	Johnson
PI Institution:	University of Michigan	

Galaxy evolution models require feedback from AGN to suppress star-formation in massive galaxies. However, the mechanisms that enable AGN feedback to reach galactic scales are hotly debated. Two key models are: (1) direct radiation pressure on dust and (2) ISM entrainment in hot winds. Measurements of the presence and properties of any hot wind component of AGN outflows thus represent a critical means of identifying dominant AGN feedback mechanisms. Sensitive and spatially resolved UV diagnostics from highly ionized emission go beyond differentiating AGN photoionized gas and shocks to serve as barometers that enable estimates of any hot wind pressure. These highly ionized UV line diagnostics (O VI/N V) were recently used to demonstrate that the dynamics of the UV emitting, outflowing clouds from a prototypical superwind driven by a radio-quiet AGN are dominated by radiation pressure with negligible compression by a hot wind. These observations indicate that this AGN outflow is driven by radiation pressure or was driven by a hot wind that has since dissipated despite ongoing AGN activity. On the other hand, AGN outflows driven along the jets of radio-loud systems are thought to be ISM entrained in a hot wind associated with the jets. To test this prediction, we propose the first spatially resolved UV spectroscopy and complementary high-resolution VLA data of a known 5-30 kpc outflow of a recently rejuvenated radio-loud AGN. This will enable unique insights into the wind driving mechanisms, the physical conditions/properties of the outflow, and a detailed study of the jet and cool outflow morphology compared to a radio-quiet case.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16707

Program Title: Precision astrometry with STIS to confirm the orbital motion of HD 106906b

Principal Investigator: Paul Kalas

PI Institution: University of California - Berkeley

The 15 Myr old spectroscopic binary HD 106906 represents a unique laboratory for studying the early dynamical evolution of planetary systems because a gas giant exoplanet has been directly imaged exterior to a central planetary system and a distorted debris disk. Several groups have proposed that the planet has been ejected from its formation site near the binary and dynamically shapes the outer disk structure, much like the hypothetical Planet Nine in our solar system is thought to control the orbital architecture of detached Kuiper Belt Objects. A key test of this hypothesis is to measure the orbital elements of HD 106906b which requires exquisite astrometric precision over many years given its 737 au separation from the binary. Using multi-epoch HST imaging with ACS, WFC3 and STIS where background stars detected with Gaia are used as an astrometric reference frame, Nguyen et al. (2021) recently measured orbital motion and contrained the orbit of HD 106906b. The findings were consistent with the hypothesis that the planet perturbs the disk. However, the result strongly depends on a single ACS/HRC point from 2004 that cannot be reproduced given that the camera is no longer functional. Here we propose to reproduce their 2017 STIS observations in Cycle 29, five years after the planet was first imaged with STIS. The sky-plane motion over this interval is expected to be greater than 3-sigma of the astrometric uncertainty. These observations will serve as a critical validation using the same instrument for two epochs of astrometry and will refine the estimated posteriors of the planetary orbital elements.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16759
Program Title:	Obtaining the UV Reddening Curve of Extreme-Rv Highly Polarizing Dust Irradiated by Zeta Ophiuchi

Principal Investigator:	Henry	Kobulnicky
PI Institution:	University of Wyoming	

Extinction and polarization by interstellar dust taints astrophysical signals, frustrating precision measurement of cosmological standard candles, electromagnetic components of multimessenger transients, and CMB signals. Understanding the origins of dust variations on small angular scales and along the line of sight in true three-dimensional detail, as informed by local physical influences, is now both possible and pressing. We propose STIS 1600-3100 A spectroscopy of five background stars probing a diffuse cloud irradiated by the O9.2IV star Zeta Oph, the nearest (182 pc) high-UV environment. Our optical polarization measurements along these mid-latitude low-confusion sightlines reveal a B field aligned with 8-micron bright filaments. The ratio of polarization to color excess, P/E(B-V), exceeds the empirical (Serkowski) limit of 9, indicating very efficient polarization and a high degree of grain alignment, plausibly from spin-up by radiative torques. The optical/infrared data indicate a reddening curve characteristic of R_V=A_V/E(B-V)<2.4, a signature of extreme dust and a size distribution favoring small grains. With measurement of the near-UV reddening slope, the height and width of the 2175 A bump, and potentially the far-UV rise, we will be able to forge a compelling association between extinction curve morphology, polarization efficiency, grain magnetic field alignment, and the dominant radiative influence of a well-characterized hot star. Characterizing the extinction of high-polarization low-Rv PAH-emitting grains in this local laboratory promotes understanding the conditions that produce anomalous dust in AGN, SNe, GRBs, and starbursts further afield.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16708
Program Title:	Testing the Existence of a 3 Solar Mass Dark Companion to V723 Mon

Principal Investigator:	Chris	Kochanek
PI Institution:	The Ohio State University	

The bright, nearby star V723 Mon has a 3 Solar mass dark companion, most easily explained as a mass gap black hole. There is no optical spectral evidence for a stellar companion, nor are there continuum eclipses, but there is evidence of a non-stellar, blue "veiling" light and eclipses of the Balmer lines. Extraordinary claims require extraordinary evidence, and so it is important to better characterize the excess UV emission. Because all but one (UVM2) of the Swift UV filters have red leaks, the shape of the UV spectral energy distribution (SED) cannot be measured with Swift in the presence of V723 Mon. A rising UV SED would strongly suggest the presence of a hot stellar companion. More generally, the UV emission is not dominated by the red giant and so is the best place to search for spectral features from any stellar companion. If it is not stellar emission, the UV is also an important probe of the origin of the claimed "veiling" light source. These questions are easily addressed with two one orbit STIS/CCD/G230LB spectra, one in eclipse and one out of eclipse.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16760
Program Title:	First detection of an isolated stellar mass black hole with astrometric microlensing
Principal Investigator:	Casey Lam
PI Institution:	University of California - Berkeley

We propose to confirm the detection of the first isolated black hole (BH), OB110462. We analyzed archival HST data with improved astrometric techniques and demonstrate that the 3 sigma lower mass limit of OB110462 is 5 Msun, making it a solid BH detection. However, the allowed mass range of the BH is quite wide (68% CI of 9-31 Msun), due to the lack of sufficient time baseline of the archival data. We propose to obtain a new measurement of the target, now 10 years after the lensing event, in order to better constrain the baseline proper motion. This will allow the mass constraints of the BH to be improved by a factor of at least 2. This will provide the first mass measurement of an isolated BH, which will inform theoretical models of massive star death, the Milky Way BH mass distribution, and the population of BH-BH binaries discovered via gravitational waves.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Intergalactic Medium and the Circumgalactic
ID:	16730
Program Title:	Connecting the Smoke to the Fire: Mapping Andromeda's Inner Circumgalactic Medium

Principal Investigator:	Nicolas Lehner
PI Institution:	University of Notre Dame

The circumgalactic medium (CGM) mediates a galaxy's accretion and feedback and may hold most of the metals it has ever produced. These findings derive from aggregating over ensembles of halos observed one galaxy at a time, and so they are limited in their ability to capture the rich density, temperature, and kinematic structure that simulations predict. Because its halo spans 30 degrees on the sky, Andromeda (M31) provides a unique opportunity to map the CGM of a single L* galaxy with dozens of sightlines and to relate the gas mass, metallicity, and kinematics to its detailed stellar populations resolved by complementary surveys. We propose to map the inner M31 CGM within 0.25 Rvir using 11 new QSOs and 2 M31 O stars, a region too sparsely sampled to characterize the most complex and influential region for galaxy evolution. When combined with existing M31 samples at larger radii, this unique program will enable compelling science goals: 1) to map ongoing accretion and feedback at the disk/halo interface, 2) to fully characterize the CGM from the disk to 2 Rvir, 3) to complete the CGM metals census that constrains outflows from the disk, and 4) to test feedback predictions from the latest zoom-in simulations of galaxy formation. Our program will also trace M31's assembly history with deep parallel images of its stellar halo. This program will yield valuable new maps of the disk-halo connection, where CGM becomes ISM, in the only galaxy for which the effects of gas flows - such as chemical enrichment by specific feedback events - can be measured at this level of detail. Our study of M31 will be the most complete picture of a galaxy's baryon cycle for the foreseeable future.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16684
Program Title:	Peak Efficiency: Mass Assembly in a Forming Supercluster at the Peak of Cosmic Star Formation Activity

Principal Investigator:	Brian Lemaux
PI Institution:	University of California - Davis

The Hyperion proto-supercluster at z~2.5 is the largest and best-studied large-scale structure observed during the peak of the cosmic star formation activity. Hyperion is the most massive overdensity yet discovered in the high-redshift universe, comparable in size and mass to present-day superclusters, and is comprised of seven distinct matter peaks, each corresponding to a proto-group or -cluster exhibiting its own unique activity. These peaks span over an order of magnitude in total mass and show a variety of levels of dynamical maturity. A small portion of Hyperion was serendipitously observed by the 3D-HST survey, revealing tantalizing indications that stellar mass assembly was proceeding rapidly in member galaxies both through star formation and merging processes.

We propose to use HST's unique capabilities, combined with existing data, to perform unbiased studies of environmentally-driven evolution in the early universe. Our program will produce a near complete map of Hyperion with WFC3 spectroscopy and imaging, confirming ~150 members (~50 in the densest peaks) - doubling the member sample and uniquely sampling the dusty star-forming and quiescent members. With this incredible sample, we will constrain the relationships between average galaxy star formation rates, stellar mass functions, and merging activity and environment. In conjunction with simulations and semi-empirical models, we will place strong constrains on different avenues of stellar mass assembly at a time when environmental quenching should be imposing itself in earnest and the vast majority of the stellar content of galaxies should be forming.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16673

Program Title: Delivering on the promise of multi-messenger astronomy

Principal Investigator: Andrew Levan

PI Institution: Radboud Universiteit Nijmegen

We propose to use the unique capabilities of HST to make the decisive next steps in the nascent field of multi-messenger astronomy. We will target the electromagnetic counterparts of gravitational wave sources identified in the next observing run (O4 mid-2022- mid-2023). These counterparts have UV/optical/IR counterparts dominated by a so-called kilonova, a faint, fast-evolving transient powered by the decay of freshly synthesized heavy elements. The ability of HST to obtain diffraction limited imaging from the UV to the IR free from the impact of atmospheric absorption, and with the resolution to minimize and ultimately remove the galaxy background makes it the ideal instrument. We will use the UV capability of HST to map the early blue UV emission, providing a direct probe of the synthesis of intermediate-mass elements. IR spectroscopy will track the production of the heaviest elements (the lanthanides). At later times our deep observations will search for any non-thermal afterglow component created by a relativistic jet viewed off-axis and characterize the merger environment in exquisite detail. Finally, these observations will measure independent distances to the host galaxies and inclination angles via kilonova properties or afterglows. This data will break the degeneracy between distance and inclination from gravitational wave data alone, greatly enhancing the Hubble constant measurements. Given this subject's high profile and interest, we both waive any proprietary period and will provide reduced data products to the community rapidly after observations.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Solar System Astronomy
ID:	16674
Program Title:	Characterization and Temporal Evolution of the Ejecta Created by the DART Impact on Dimorphos
Principal Investigator:	Jian-Yang Li
PI Institution:	Planetary Science Institute

NASA's Double Asteroid Redirection Test (DART) mission will hit Dimorphos, the satellite in the binary near-Earth asteroid system (65803) Didymos in late September 2022 for a controlled asteroid impact experiment. We request 19 orbits to observe the DART impact ejecta for a total duration of three weeks to characterize its morphology and temporal evolution, and to constrain the mass, velocity and velocity distributions, particle size and size frequency distributions of the ejecta. Impact is a common and important process naturally occurring in all planetary systems and plays an important role in the evolution of planetary objects. The DART mission is the first experiment to demonstrate asteroid impact hazard mitigation by using a kinetic impactor, with its primary objective being to measure the momentum transfer efficiency during asteroid impact on a realistic asteroid scale. Although HST has observed naturally occurring impacts in the past, the DART impact is the first asteroid impact with precisely known impactor properties and a considerable amount of detailed knowledge about the target and impact site. Therefore, the proposed observation will both greatly improve our knowledge about impacts on asteroids, and significantly strengthen the coordinated global observing campaign organized by the DART investigation team. HST is the only observing facility that is capable of high-resolution, high sensitivity imaging of the full extent of the DART ejecta for the full duration of ejecta development and dissipation.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16731
Program Title:	Leveraging High Radial Velocities to Get to the Core of Planetary Lyman-alpha Transits
Principal Investigator:	R. O. Loyd
PI Institution:	Eureka Scientific Inc.

Lyman-alpha transit observations of warm, gas-rich exoplanets enable the study of active atmospheric loss. However, obscuration of the inner +/-30 km/s of the Lyman-alpha core by the interstellar medium (ISM) severs a key link between the velocities at which planetary outflows are observed and the ~10 km/s velocity at which they initially depart the planet. Systems with high radial velocities (RVs) can circumvent this limitation by Doppler-shifting the Lyman-alpha core away from ISM absorption. We propose Lyman-alpha line core transit observations of HD 136352 c, a transiting warm sub-Neptune orbiting a nearby solar analog. HD 136352 c is presently uniquely suited to these observations. However, because of the diagnostic power of transit observations in the Lyman-alpha line core, we also include a Lyman-alpha survey of 5 additional high RV targets hosting warm, gas-rich planets to confirm Lyman-alpha core visibility in an expected 1-3 systems. These Lyman-alpha transit observations of HD 136352 c and, in future cycles, the 1-3 systems found to have exposed line cores will provide an observational link between material accelerated beyond the 30 km/s limit and its source at the planet. This will provide new constraints on the interactions between planetary outflows and their circumstellar environments, ultimately improving model-dependent mass loss estimates and providing insight into the impact of hydrodynamic atmospheric loss on the evolution of planetary populations.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16658
Program Title:	Hunting for Black Holes with Astrometric Microlensing

Principal Investigator:	Jessica Lu
PI Institution:	University of California - Berkeley

Although there are likely 10^7 - 10^9 stellar mass black holes (BHs) in the Milky Way, only a handful have been detected in the Universe, all in X-ray binaries or BH-BH mergers; no isolated BHs have been definitively detected. A census of isolated BHs will provide important constraints on stellar evolution, the Milky Way BH mass function, supernovae physics, and BH/neutron star formation. Gravitational microlensing is ideal for finding isolated BHs, as properties of the lens can be inferred from changes in the brightness and position of a background star. By combining both the photometric and astrometric microlensing signal, we can directly determine the lens mass. We propose to use HST to measure the astrometric shift of 4 likely BH microlensing candidates. Combined with other ongoing measurements, this will allow us to constrain the number of BHs in the Milky Way to better than 50%, a major improvement over the current orders of magnitude uncertainty. This will also enable the first constraints on the Milky Way BH mass function, binarity, and kick velocities.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16709
Program Title:	Probing Massive Shell Eruptions of Superluminous Supernovae in the UV

Principal Investigator:	Ragnhild	Lunnan
PI Institution:	Stockholm University	

Hydrogen-poor superluminous supernovae (SLSN-I) are a rare class of transients with peak luminosities 10-100 times those of ordinary supernovae and with unique spectra. Neither the energy source behind their enormous luminosities, nor their progenitor stars, are well understood. There is increasing evidence, however, that some SLSN-I experience significant mass-loss close to explosion, with two objects now having been found with fast-moving (v ~ 3000 km/s) circumstellar shells of material. These shells are best explained by the pulsational pair-instability mechanism, and potentially link these supernovae to very massive progenitors (core mass ~50 Msun). Analysis to date has been limited by not being able to constrain the ionization state, composition and ultimately the mass of these shells, however, which offers key tests of the proposed pulsational pair-instability scenario. This information can only be obtained through UV absorption spectroscopy while the supernova is near peak light. Here, we propose target-of-opportunity observations with COS/FUV and STIS/MAMA to obtain UV spectroscopy of the next SLSN-I with evidence of a CSM shell and at a suitable redshift and brightness for HST, which will allow for these crucial pieces of information to be determined. Beyond studying the shell, the supernova spectrum itself in the UV carries valuable information for both the potential powering source, and the metallicity of the progenitor. It will also add to the small but growing number of nearby, well-studied SLSNe with HST UV spectra, necessary for interpreting the rest-frame UV spectra of SLSNe found at higher redshifts by future missions like LSST, Roman and even JWST.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16746
Program Title:	Reconstructing Andromeda's accretion history with remote globular clusters: a pilot proper motion study

Principal Investigator:	Dougal	Mackey
PI Institution:	Australian National University	

Resolved observations of the stellar halos of nearby galaxies yield critical insight into the mass assembly history in these systems, allowing the predictions of cosmological models to be directly confronted with experimental data. Andromeda (M31) is a key location for this endeavour, offering a second data point, and exhibiting strikingly different halo properties, to the Milky Way. Here we propose to take the first step towards obtaining full 6D orbital phase-space information for stellar substructures in the M31 halo, by undertaking a pilot survey to measure proper motions for a small set of globular clusters with first-epoch ACS/WFC imaging taken 11-17 years ago. By comparison with recent HST proper motion studies of larger stellar systems out to the distance of M31, we expect to achieve a precision of ~0.010-0.015 mas/yr with these baselines. This compares favourably with the observed 1D (line-of-sight) kinematics of M31's outer globular cluster system, which exhibit a velocity dispersion of ~100 km/s (0.027 mas/yr) plus coherent rotation of comparable amplitude. These pilot measurements will provide the first 6D phase-space information for any extragalactic stellar stream, and enable a new, independent estimate of the shape and mass of the M31 dark halo at very large radii (50-120 kpc). By demonstrating feasibility and optimising our methodology with this data set, we ultimately aim to extend similar measurements to a much larger cluster sample in future, facilitating detailed orbital modelling that will accurately reconstruct the main events in M31's accretion history.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16710
Program Title:	Measuring ionizing photon escape from an exceptionally bright gravitationally lensed arc at z=1.43

Principal Investigator:	Ramesh	Mainali
PI Institution:	NASA Goddard Space Flight Center	

We propose WFC3 UVIS/G280 grism observations to measure escaping ionizing photons (LyC) from a galaxy at z=1.43 having nebular conditions similar to reionization era systems. The galaxy is a uniquely bright (r~20) gravitationally lensed system with an extended arc (9" long) allowing ionizing photon escape at a sub-kpc level. Based on a newly developed indirect measure of LyC escape fraction using Mg II emission lines, the galaxy is inferred to be a strong LyC leaker with ionizing photons escape fraction (dust corrected) of 27+/-4%. The proposed observations will (i) directly test the utility of Mg II based measure of LyC escape fraction for a high redshift galaxy, (ii) provide a sub-kpc map of ionizing photon escape allowing detailed probe of LyC escape. To date, only one source exists at any redshift where a spatially resolved study of LyC photons is possible. However, it is not clear whether the source is representative of reionization era galaxies. 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.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16775

Program Title: The Last Gasp of the TDE Wind

Principal Investigator: Walter Maksym

PI Institution: Smithsonian Institution Astrophysical Observatory

When a star is tidally disrupted by a supermassive black hole, the rapid accretion of the stellar debris may drive super-Eddington winds which. After a period of accretion rate decay, we expect the winds to "shut off", drastically reducing the production of broad line emission and changing the evolution of the band-specific light curve across the spectrum. Spectroscopic monitoring of new tidal disruption events (TDEs) in the ultraviolet is the best place to observe this transition due to the persistence of a windless disk continuum. the lack of stellar contamination, and the wealth of high-ionization diagnostic lines that probe the relatively small TDE accretion structure. We propose to observe 5 TDEs over 3 epochs with monitoring UV spectroscopy and complementary X-ray and optical observations, in order to observe this transition and investigate its connection to the evolution of the accretion flow. Beyond this primary goal, these observations will also provide an important legacy contribution of HST towards understanding TDE physics in the UV.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO
Scientific Category: Galaxies
ID: 16762
Program Title: Probing the Origins of BST1047+1156, the Most Diffuse Star Forming Galaxy

Principal Investigator: Chris Mihos
PI Institution: Case Western Reserve University

The recently discovered galaxy BST 1047+1156 is the most diffuse star-forming galaxy found to date. Located in the Leo I galaxy group (D=11 Mpc), its extremely diffuse nature tests models of both galaxy formation and star formation at the lowest densities. BST1047's extraordinarily blue optical colors and UV emission both signal a recent episode of star formation in the object, even though its HI column density is well below that in which star formation typically occurs. Exactly how BST1047 formed remains unclear: it may be either a long-lived but extremely diffuse LSB galaxy caught in a tidal interaction, or a recently spawned tidal dwarf caught in the throes of disruption. Either scenario places BST1047 at the extreme limits of our understanding of galaxy evolution processes.

To resolve the question of BST1047's origins, we propose deep F606W/F814W imaging to construct a color magnitude diagram of its resolved stellar population and constrain the ages and metallicities of its stars. This will cleanly differentiate between the two formation scenarios, as the presence of old red giant branch stars would rule out the young tidal dwarf model. A purely young stellar population would mark BST1047 as a disrupting tidal dwarf, the first such object known, providing a new link between tidal interactions and dwarf galaxy formation and disruption. We will also place BST1047 on the well-determined stellar mass-metallicity relationship for normal star forming galaxies, providing another important test of its origins. Finally, we will use the BST1047's populations to probe the spatial distribution of recent and past star formation in this anomolous object.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16732
Program Title:	Caught in the Act: UV spectroscopy of the ejecta-companion collision from a type Ia supernova
Principal Investigator:	Adam Miller
PI Institution:	Northwestern University

There is now significant observational evidence for both of the leading models proposed to explain the origin of type Ia supernovae (SNe). While the majority of SNe Ia likely come from the merger of two white dwarf (WD) stars (known as the double degenerate model), a significant fraction are the result of a WD accreting mass from the hydrogen envelope of a binary companion (known as the single degenerate model). Eventually, as the accreting WD approaches the Chandrasekhar limit, the onset of unstable burning leads to a thermonuclear explosion. With observational evidence for both channels firmly in place, future efforts to better understand the progenitors of SNe Ia will require detailed studies of individual systems.

A fundamental expectation of the single degenerate model is that the collision of the blast wave with the donor star will produce a unique signature - a bright and rapidly declining UV pulse. This UV signal has only been previously observed in a single SN. Here, we propose to undertake STIS UV spectroscopy of one infant type Ia SN with similarly strong UV emission. The spectra will provide unique and detailed insight into the ejecta-companion interaction while also probing the chemical abundance of the outermost layers of the SN ejecta. The ejecta-companion signature is only visible in the UV, and HST/STIS is the only instrument capable of obtaining the spectra that are needed as a detailed probe of the interaction physics.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16763
Program Title:	Tracking down the origin of UV photons in local high-z analogues with FUV emission line imaging

Principal Investigator:	Matilde	Mingozzi
PI Institution:	Space Telescope Science Institute	

Far ultraviolet emission lines are fundamental to interpret the ionized interstellar medium (ISM) properties of the first generation of galaxies that will be observed with the James Webb Space Telescope (JWST). The COS Legacy Archive Spectroscopic SurveY (CLASSY) HST/COS treasury program provided the first high-resolution spectral catalog of local high-z analogues to investigate their stellar and gas properties to improve the diagnostic power of UV lines. However, in order to fully understand the physical conditions that give rise to their excitation, we need to spatially tackle these diagnostics. This will allow us to trace their spatial distribution and to isolate the origin of the UV photons within these systems. Here we propose to obtain emission line images down to ~10 pc resolution, using the high resolution imaging from ACS and STIS, of three nearby well-known low-metallicity starbursts selected from CLASSY. These sources are remarkably characterized by strong CIV1548,1551, HeII1640, [OIII]1661,6 and [CIII]1907,CIII]1909, and by different Ly-alpha profiles. The powerful combination of available optical integral field spectroscopy data, archival and new HST observations in concert with state-of-the-art models will allow us to investigate and interpret the morphology of the emission line diagnostics. Hence, not only we will be able to track the ionization source(s) of the gas and the ionization structure in our targets, but also test indirect tracers of leaking ionizing radiation (i.e., Lyman continuum escape). This study will provide us with an extremely powerful toolkit, pivotal for understanding the ISM conditions of the earliest galaxies.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16747
Program Title:	FUV-Optical Spectroscopic Mapping of the PDRs in NGC7023 and The Horsehead

Principal Investigator:	Karl	Misselt
PI Institution:	University of Arizona	

Photodissociation regions (PDRs) are predominantly neutral regions of the ISM in which the heating and chemistry are mainly regulated by far ultraviolet photons. They are extended regions at the interface between bright stars and molecular clouds, and contain dense structures and clumps immersed in a more diffuse medium which are subjected to photo-evaporation, which brings fresh matter into the diffuse hotter zone. The interaction of stellar radiation with in situ material includes: 1) the disruption of grain mantles/clusters and coagulated grains formed in shielded dense regions, 2) ionization and dissociation of the gas and 3) gas and dust heating. Studies of nearby PDRs have shown that these processes are strongly stratified and active on angular scales that can be as small as ~1" (0.002 pc/400 au at a distance of 400 pc), indicating that the physical conditions vary over orders of magnitude on small spatial-scales in PDRs. Nearby PDRs are therefore unique targets to study rapid variations in the dust and gas components as a function of the excitation and physical conditions. In light of the importance of PDRs in understanding ISM physics and chemistry, we propose to use STIS on HST to study two emblamematic PDRs, the Horsehead and NGC7023, at wavelengths covering the dominant energy input into the PDR, the optical and UV. These data will provide data that complements an accepted JWST GTO program combining imaging and spectroscopy of both PDRs. We will observe regions matched to the apertures defined in the JWST program from ~100-1000 nm using four STIS gratings, two paired with the STIS MAMA detectors and two with the STIS CCD detectors, all four in low resolution.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16764
Program Title:	The Stars Like Dust: Inferring a Probabilistic Extinction Law from STIS UV Spectroscopy of the Cosmic Flux Standards

Principal Investigator:	Gautham	Narayan
PI Institution:	University of Illinois at Urbana - Champaign	

Our understanding of dust, encoded in our knowledge of the extinction law, is one of the leading sources of systematic bias impacting cosmology today. We propose to measure the extinction law, and its variation, directly through STIS FUV and NUV spectroscopy of 21 faint white dwarf stars, the Cosmic Flux Standards. These standards have SEDs that are exceptionally well-constrained by high S/N legacy HST panchromatic imaging, detailed ground-based optical spectroscopy, and temporal monitoring to assess variability. These Cosmic Flux Standards extend the CALSPEC system down to V~19.5 mag, and has been demonstrated that measurements of these standards will allow 1% absolute photometric calibration and 0.5% relative calibration, suitable for major upcoming projects such as the Vera Rubin Observatory and Nancy Grace Roman Space Telescope. These observations will allow a direct measurement of the extinction law by comparing the STIS spectrophotometry to the unreddened SEDs of the Cosmic Flux Standards, allowing a population inference of the extinction law, as well as line-of-sight estimates to each object. This probabilistic model of the extinction law will directly address dust as a source of systematic error, and the STIS FUV and NUV observations will also extend the validity of the standards to 1,150 Angstrom in preparation for future UV space-missions.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 16675
Program Title: Observing Jupiter's FUV auroras during the Juno Extended Mission

Principal Investigator: Jonathan Nichols

PI Institution: University of Leicester

In September 2021, the highly successful NASA Juno spacecraft will begin its Extended Mission (EM). During the EM, Juno will cross the equatorial region inside of Ganymede's orbit providing an opportunity to obtain HST auroral images simultaneously with high-resolution in situ observations in the crucial inner equatorial region of Jupiter's magnetosphere, where the key dynamics that drive and shape the magnetosphere originate. The STIS/FUV imaging observations proposed here over Cycles 29-31 will answer a large number of outstanding scientific questions, including:

* Do magnetosphere-ionosphere coupling currents drive Jupiter's main auroral emission?
* What radial forces govern the structure of Jupiter's magnetosphere?
* What is the nature of the interaction between Jupiter and its satellites?
* How do Jovian plasma populations relate to low latitude auroral emissions?
* How does magnetospheric wave activity influence Jupiter's magnetosphere?
* What processes give rise to pulsating high-latitude emissions?

This program responds to the UV initiative and is only possible during the Juno EM. These observations cannot be made by Juno UVS and HST is the only observatory capable of making these FUV observations, which will yield high-impact results, and complement and extend the goals of the NASA Juno mission.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16748

Program Title: Proper motions of the star cluster system of the Large Magellanic Cloud

Principal Investigator: Florian Niederhofer

PI Institution: Leibniz-Institut fur Astrophysik Potsdam (AIP)

A number of high-precision proper motion programs utilizing HST have already been used to study different aspects of the Magellanic Cloud system, thereby having a tremendous impact on our understanding of this pair of interacting galaxies and its relation to the Milky Way. It has been shown that both Clouds move much faster than previously assumed, suggesting they are most likely on a first passage around the Milky Way. Also, the internal rotation pattern of the Large Magellanic Cloud (LMC) in the plane of the sky has been revealed for the first time using data from HST. However, to date little is known about the dynamics of the star-cluster system within the LMC. To eliminate this lack of knowledge, we propose here for an additional epoch of HST observations for a sample of 19 massive LMC star clusters that span a wide range of ages and galactocentric distances to get, for the first time, a precise measurement of the clusters' proper motions. This program aims to use star clusters as tracers to probe the gravitational potential of the LMC, to study the kinematic pattern of the LMC as traced by star clusters at various ages and also to place important constraints on the interaction history of the Magellanic Cloud system.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Intergalactic Medium and the Circumgalactic
ID:	16749
Program Title:	Direct imaging of CGM substructure with 50 parsec resolution

Principal Investigator:	Nikki	Nielsen
PI Institution:	Swinburne University of Technology	

Starbursting galaxies present the best laboratory to study the CGM since they are likely undergoing strong accretion events which trigger intense star formation-driven outflows. However, very few observations exist that have directly imaged their CGM and quantified the fine-scale substructure. Recent ultra-deep Keck/KCWI observations have mapped optical emission lines in the CGM to a distance of over 30 kpc from IRAS08, a nearby starbursting galaxy with evidence for an ongoing accretion event. These KCWI observations contain bright emission line knots with sizes of order hundreds of parsecs and no evidence of stellar continuum, implying a lack of stars. The properties of these emission knots are consistent with cool, condensing clouds in recent simulations. However, the sizes from KCWI are near the seeing limit, and the continuum measurement is hampered by sky subtraction uncertainties. We aim to use HST to zoom in on this substructure in the CGM of IRAS08 and test hypotheses explaining the sub-kiloparsec features. We propose for 5 orbits of WFC3/UVIS to obtain the Halpha+[NII] (F665N) and broad-band starlight (F467M & F775W) to measure the sizes and fluxes of the CGM emission knots. These data will allow us to differentiate between three possible scenarios giving rise to these knots, including the cool condensing clouds predicted in high resolution simulations, external HII regions, and dwarf galaxies. These observations are part of a larger program to directly image the optical emission lines of the CGM in starbursting galaxies. This HST imaging will therefore be a Rosetta Stone for interpreting future data as we move into the new era of direct imaging of the CGM.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Solar System Astronomy
ID:	16712
Program Title:	Constraining the Orbit of Eurybates' Satellite, Queta

Principal Investigator:	Keith	Noll
PI Institution:	NASA Goddard Space Flight Center	

(3548) Eurybates will be the first Trojan asteroid to be explored in situ when the Lucy spacecraft flies by it in August 2027. The possibility of close-up study of Eurybates' satellite, Queta, offers a unique opportunity to test whether Eurybates' unusual properties are tied to its collisional history and, more broadly, how collisional evolution shapes small body populations. It is critical to reduce the orbital uncertainty and improve knowledge of the relative position of Queta as soon as possible to understand if there could be an impact to Lucy's encounter concept of operations and to optimize planning for the best angular resolution and lighting conditions in the brief window when observations can be made. By establishing a tighter constraint on the current orbit, it will be possible to accelerate searches for non-Keplerian motion should there be an additional satellite or satellites interior to Queta (as are commonly found in other collisional-family satellite systems). Additionally, we will use astrometric information from trailed stars in the full UVIS aperture to improve predictions for future stellar occultations. HST is required because Queta is 8.7 magnitudes fainter than Eurybates and will be observed at a separation of 0.5 arcsec - an observational regime that is unique to Hubble.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Supermassive Black Holes and AGN
ID:	16713
Program Title:	The Hosts of Quasars with Newborn Jets Discovered in the Very Large Array Sky Survey

Principal Investigator:	Kristina	Nyland
PI Institution:	Naval Research Laboratory	

We propose a WFC3/IR imaging study of the hosts of 4 quasars that were recently caught launching newborn jets by the Very Large Array Sky Survey (VLASS). The targets are broad-line (type 1) SDSS quasars at $0.2<z<1.0$ that have transitioned from radio-quiet to radio-loud in the past 10-20 years. Extensive multi-wavelength follow-up observations in the radio and X-ray probing the jets and accretion states are underway, but the properties of the host galaxies remain unknown. The unmatched combination of angular resolution and PSF stability of HST is needed to enable accurate quasar/host galaxy decomposition and gain insights into the conditions under which quasar jets are born. Our proposed observations will measure the morphologies, sizes, and luminosities of the hosts of newborn quasar jets for the first time. A total of 4 orbits are required. Our sample size and observing request are modest, but will pave the way for larger studies in the next few years as new VLASS epochs continue to identify new candidates. We will compare the host properties of our sample with those of previous studies of quasar hosts. Our proposed study will help guide future campaigns with HST and JWST to determine the host galaxy properties and conditions under which jets are triggered.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Supermassive Black Holes and AGN
ID:	16693
Program Title:	The host galaxy and environment of a radio galaxy near the epoch of reionization

Principal Investigator:	Roderik	Overzier
PI Institution:	Observatorio Nacional	

Radio-loud active galactic nuclei (RLAGN) are the most luminous radio sources in the Universe, and RLAGN at high-z are important for studying the formation of massive galaxies and supermassive black holes (SMBHs). The discovery of a radio galaxy at z=5.72 (TGSS J1530+1049) has pushed studies of RLAGN closer to the epoch of reionization (EoR). HST imaging of other high-z radio galaxies has shown that such systems are massive, with intense star-formation. They exhibit complex morphologies, large sizes and are frequently surrounded by overdensities of faint galaxies, indicative of a forming cluster environment. TGSS J1530+1049 at z=5.72 offers an opportunity to now investigate these phenomena at z~6, and we propose deep multi-band HST imaging with ACS and WFC3 to image the radio galaxy and its close companions, searching for overdensities on scales of 5 Mpc (co-moving) in its environment.

TGSS J1530+1049 is a JWST NIRCam GTO target and is the subject of an approved Cycle 1 NIRSpec/IFU program. It benefits from high-resolution VLBI radio imaging of its AGN jets and is an approved Chandra target. The combination of these proposed HST observations with JWST data will result in maps of the distribution of stellar mass and measurements of star-formation rate, dust, ionisation state and metallicity of the gas. Correlating the rest-UV morphology with AGN jets and constraining the evolutionary stage of the stellar populations are crucial to understand AGN feedback in massive galaxies near the EoR. Further, rest-frame UV HST imaging will allow the identification of any nearby companions through Lyman break selection, which will not be possible from the NIRCam data alone.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16659

Program Title: Accreting white dwarfs as probes of compact binary evolution

Principal Investigator: Anna Pala

PI Institution: European Southern Observatory - Germany

In the last 20 years, the study of compact interacting binaries has led to two major breakthroughs in astrophysics: the discovery of dark energy and the first detection of gravitational waves. Although binaries are critically important to probe the properties of the Universe and to test fundamental physical theories, our understanding of their evolution and final fate is still far from being complete.
Accreting white dwarfs are ideal laboratories in which to test the models of compact binary evolution. We here propose a COS Treasury program specifically designed to explore those regions of the parameter space that have been previously poorly studied and where major discrepancies between the theory and observations are found. Combining the high-quality ultraviolet data with the parallaxes from Gaia, we will accurately measure effective temperatures, masses and accretion rates for 43 accreting white dwarfs (the minimum number required to homogeneously sample the entire physical parameter space spanned by this diverse population) thereby testing the mechanisms of angular momentum loss which drive the evolution of all kinds of binaries. The white dwarf masses are a key ingredient in the pathway toward Supernova Type Ia explosions and by obtaining their accurate values, we will constrain both the single and the double-detonation scenarios. Finally, only the ultraviolet allows the detection of the nitrogen and carbon resonance lines. From their abundances, we will establish the formation channel for the most compact systems, which will later be used to verify the performance of the space-mission LISA and calibrate the detector for future gravitational wave source discoveries.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16646
Program Title:	Exposing the Lyman-alpha Profiles of Low-Mass Stars

Principal Investigator:	Sarah	Peacock
PI Institution:	NASA Goddard Space Flight Center	

Characterizing potentially habitable planets around low mass stars is a key focus of current and upcoming missions such as JWST and TESS. This focus stresses the need for a comprehensive understanding of the radiation environments in which such planets reside. Low-mass stars are typically much more active than solar type stars and the proximity of their habitable zones can be one tenth the distance. The far-ultraviolet (FUV) radiation emitted by these stars has the potential to alter an orbiting planet's atmospheric photochemistry, while the extreme-ultraviolet (EUV) radiation can cause the loss of planetary atmospheres and surface volatiles. Ly-a emission at 1216 A is the dominant radiation source for low mass stars at FUV wavelengths and is critical for informing stellar atmosphere models used to predict the EUV spectrum, but directly measuring a low-mass star's Ly-a emission is almost always impossible because of the contaminating effects of interstellar hydrogen. Using Gaia DR2, we have identified a unique sample of six low mass stars for which a complete and accurate measurement of their Ly-a line profile is possible due to their very large radial velocities. Stars with very large radial velocities (>100 km/s) will have their Ly-a emission Doppler shifted away from contaminating sources allowing for the rare opportunity to measure intrinsic Ly-a emission. These proposed observations of this rare sample of stars will triple the number of stars with Ly-a emission measured in this way and will improve the accuracy of computed spectra for all low-mass stars across wavelengths that drive planetary atmospheric evolution.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16714
Program Title:	HST Spectroscopy of a Fast-Rising Luminous Ultraviolet Transient

Principal Investigator:	Daniel Perley
PI Institution:	Liverpool John Moores University

High-cadence time-domain surveys have unveiled a population of fast-evolving, luminous extragalactic transients with SEDs that remain dominated by ultraviolet emission for long after peak and also exhibit luminous X-ray and radio counterparts. While they show some observational similarities with strongly-interacting supernovae, optical follow-up has failed to identify any recognizable supernova features and the extreme properties of these events strain theoretical models for what is possible in a supernova explosion. Ultraviolet spectroscopy has the power to reveal similarities or differences betwen this event and other supernova classes not apparent from optical observations alone, and offers a means of identifying the progenitor star via transmission spectroscopy of the dense stellar wind before the explosion sweeps it up. We propose to obtain target-of-opportunity UV spectroscopy of a new event of this type in Cycle 29 to secure the physical origins of this class while HST's unique UV spectroscopic resource is still available.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16660

Program Title: Inside out: detecting a rock vapor atmosphere on the lava world TOI-2431 b

Principal Investigator: Samuel Quinn

PI Institution: Smithsonian Astrophysical Observatory

Existing on the extreme edges of the exoplanet population, ultra short period (USP) rocky planets offer new opportunities to study the physicochemical properties of planetary interiors, surfaces, and atmospheres. The immense irradiation and tidal forces experienced by these planets open observational avenues that remain closed for their long-period counterparts: their primordial atmospheres photoevaporate, opening their surfaces to observation; their tidally locked daysides melt and vaporize, enabling observation of surface material in new phase states; and unless heat is redistributed efficiently, their rock vapor atmospheres may condense on their cold nightsides. We propose for 11 orbits of WFC3 data to measure the phase curve of the lava world TOI -2431b, a rocky planet with a 5.4-hour orbital period, the shortest among planets with a known density. It is the best rocky planet for thermal emission studies using HST/WFC3, and with the majority of the sky now surveyed by TESS, it is likely to remain so. The planet is expected to have lost its primordial atmosphere, but it may well possess a rock vapor atmosphere sustained by its surface magma ocean. These observations will allow us to: 1) determine the Bond albedo of the planet, which can constrain the properties of the surface magma ocean; 2) to detect a rock vapor atmosphere or a thicker volatile atmosphere from its spectrum or the presence of a hotspot offset indicative of heat redistribution; and 3) constrain the interior structure by refining the planetary radius and iron mass fraction of the planet, which will help inform USP planet formation models and the design of future observations.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16647
Program Title:	The HST probes the winds and feedback of metal poor OB stars in the tidally stripped Magellanic Bridge

Principal Investigator:	Varsha	Ramachandran
PI Institution:	Universitat Potsdam	

Metallicity is one of the most fundamental parameters governing both stellar and galactic evolution. However, the impact of metallicity on the physics of massive stars and their feedback is empirically not well constrained at low metallicities. The Magellanic Bridge, which is our nearest tidally interacting environment with significantly low mean metallicity Z<~0.1Zsol, offers a unique laboratory for this study. Recently three O-type and few early B-type stars in the Bridge were identified via optical spectroscopy. This newly discovered sample will allow to characterize the winds of metal-poor massive stars and to empirically establish the scaling of mass-loss with metallicity, which cannot be done by using optical data alone. We selected 6 UV brightest OB stars as targets to obtain COS FUV spectra. The spectra will be analyzed using advanced non-LTE stellar atmosphere models, thereby determining the stellar, wind parameters, and Fe abundances of individual massive stars in the Bridge. The empirical mass-loss rates at low metallicity will be used to constrain stellar evolution models. Two B stars in our sample showing high UV excess are suspected to be binaries and might hide a hot companion. The far UV spectra are crucial to identify and characterize the stripped He companions of B stars which are not found yet at low metallicity. The UV + optical spectral analysis is essential to quantify ionizing fluxes as well as mechanical energy provided by OB stars at low metallicity. Together with physics and abundances of diffuse gas from ISM lines, our study will shed light on stellar feedback and star formation, as well as constrain the formation history of the Bridge.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16750
Program Title:	Inhomogeneities and pristine gas infall in the ISM

Principal Investigator:	Tanita	Ramburuth-Hurt
PI Institution:	University of Geneva-Department of Astronomy	

Is the neutral ISM in the Galaxy clumpy? Does pristine gas infalling on the disk immediately mix with the metal-enriched gas? Recent medium-resolution STIS studies found frequent sub-solar metallicities in the neutral ISM, integrated along the line of sight, suggesting the contribution of low-metallicity gas. Intriguingly, in some cases deviations from the expected depletion patterns were observed for volatile elements. One possible explanation for both effects is a mix between metal/dust-rich and pristine gas (low metallicity and zero depletion) in the ISM. Indeed, an inhomogeneous ISM mix has been recently observed in high-resolution STIS observations of HD 62542. Here we propose to target 8 lines of sight that show potential contribution of pristine gas in the following ways: 1) low metallicity integrated along the line of sight, 2) deviations in the depletion of the volatile elements, and 3) complex/asymmetric kinematics, as measured from lower-resolution studies. The STIS high-resolution will enable a component-by-component analysis to characterize the depletion properties of individual clumps. Our primary goal is to constrain dust-rich and dust-free ISM clumps towards our targets. In addition, we aim at roughly constraining the metallicity of these ISM clumps by exploring the parameter space that can reproduce the observed deviations of the volatile elements. This way we will characterize the inhomogeneities in the ISM and unveil the potential presence of clumps of pristine gas. While chemical evolution models show that infalling pristine gas is necessary to sustain star formation and reproduce the observed abundances, its presence in the ISM is yet to be confirmed.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16648
Program Title:	Atmospheric Evolution and Loss of a Recently Discovered Low-Density Ultra-Short Period Super-Earth

Principal Investigator:	Seth	Redfield
PI Institution:	Wesleyan University	

Super-Earth characterization continues to be a particular focus of the field given that it is the interface between terrestrial planets and gas-dominated planets. The implications of this division reverberate in planet formation, planetary interiors, and the origins and evolution of planetary atmospheres. A recently discovered ultra-short period exoplanet, TOI-1685b, is the lowest density super-Earth to orbit a small, low-mass star. Its low density and small host star, make it an ideal candidate for extended atmosphere characterization and a measurement of super-Earth mass loss. TOI-1685b has a relatively hot atmosphere, which makes it an excellent target for measuring atmospheric hydrogen escape, particularly given its close orbit, deep within the stellar wind of its host star. Measurements of hydrogen escape provides constraints on the evolution of the planetary atmosphere. We propose spectroscopic observations of two planetary transits to measure the stellar Lyman-alpha emission line and search for signatures of an extended hydrogen atmosphere. The Lyman-alpha line is also the dominant source of UV emission for cool stars, and thereby has a tremendous impact on planetary atmospheres. These observations, along with a short near-UV observation of MgII, the second most dominant emission line, will provide a vital characterization of the stellar inputs into all of the planetary atmospheres in this system. Observations of hot and largely cloud-free atmospheres, particularly of super-Earths like the one requested in this proposal, are an important step in planning future observations of temperate planetary atmospheres.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Supermassive Black Holes and AGN
ID:	16661
Program Title:	Dwarf Galaxies with Radio-Selected Massive Black Holes

Principal Investigator:	Amy Reines
PI Institution:	Montana State University - Bozeman

Studies of massive black holes (BHs) in nearby dwarf galaxies can provide important constraints on the birth and growth of the first seed BHs in the early Universe. Using high-resolution observations from the Very Large Array, Reines et al. (2020) discovered a set of compact radio sources in nearby dwarf galaxies with luminosities indicative of accreting massive BHs. Moreover, some of these radio sources are not in the centers of the galaxies with offsets on the order of ~1 kpc. As part of a pilot study, we propose HST/WFC3 observations of 3 dwarf galaxies hosting radio-selected ("wandering") massive BHs that also have guaranteed X-ray observations with Chandra. We propose narrow-band H-alpha imaging and wide-band optical continuum imaging to 1) determine spatially-resolved star formation rates and colors, 2) search for faint, small optical counterparts of the BHs, and 3) determine detailed morphologies of the dwarf host galaxies. The proposed observations are crucial to asses possible contributions from star-formation-related emission at X-ray and radio wavelengths, and characterize the properties of this new class of BH-hosting dwarf galaxies.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16715

Program Title: Coronagraphic Imaging of the Iconic Quasar 3C 273

Principal Investigator: Bin Ren

PI Institution: California Institute of Technology

Recent understanding of HST/STIS coronagraphic high contrast imaging mode can enable the study of quasar surroundings in visible light at high-contrast and high-resolution. We request 8 orbits of coronagraphic imaging mode to observe the surrounding environments for quasar 3C 273 with STIS as a first science demonstration of this mode. Using the recently commissioned BAR5 occulter, we can probe the host galaxy morphology and features of the quasar's circumnuclear environment down to 0.2 arcsec, or ~520 pc. In our preparatory work, on the one hand, we have discovered new host galaxy structures at ~1 arcsec in the re-analysis of non-coronagraphic STIS observations of 3C 273; on the other hand, our pilot Keck/NIRC2 near-IR observation has revealed a candidate circumnuclear disk with a diameter of ~1 kpc. Coronagraphic observations with STIS will not only help characterize this candidate structure, provide critical constraints for determining whether the host galaxy is undergoing a merger, but also provide an unprecedented view of the surroundings of 3C 273 in visible light. Moreover, combined with archival re-analysis, we can establish a ~20 year baseline to study apparent motion for its jet. This project further demonstrates the necessity of multi-instrument coronagraphic imaging from visble to near-infrared in understanding the surrounding environments of quasars.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Large Scale Structure of the Universe
ID:	16676
Program Title:	A 1% Calibration of the Distance Ladder from Cepheids Using High Precision Cluster Parallaxes to Reveal the Origin of the Hubble Tension

Principal Investigator:	Adam Riess
PI Institution:	The Johns Hopkins University

Observations of Cepheids with HST show the Universe is expanding significantly faster than expected under the assumption of LCDM calibrated with measurements from the early Universe. The significance of this remarkable result has reached 4-6 sigma and passed numerous tests of robustness. Improving the measurement of the Hubble constant now can move us beyond merely detecting this discrepancy to identifying its origin. We propose to obtain HST photometry of Cepheids hosted by open clusters in the Milky Way whose large number of stars provide the highest parallax precision available in Gaia EDR3, a factor of more than three better than what is possible for individual Cepheids. To fully exploit these Cepheids to calibrate the distance ladder we propose to observe these Cluster Cepheids with spatial scanning and the same WFC3 three-band photometric system used for extragalactic Cepheids to nullify the effects of photometric zeropoint errors along the distance ladder. This program will surpass the best available calibration of the distance ladder to enable a 1% measurement of the Hubble constant and increase its leverage for identifying the source of the discrepancy. Gaia and HST, each doing what they do best, can continue to steadily advance our knowledge of what appears to be a new feature in the cosmological model

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16733
Program Title:	Mapping the escape of Ly alpha and ionizing photons from an extreme emission-line lensed galaxy

Principal Investigator:	Jane Rigby
PI Institution:	NASA Goddard Space Flight Center

We propose 10 orbits of HST WFC3-UVIS G280 slitless grism spectroscopy of S1723, an extremely bright gravitationally lensed galaxy at redshift z=1.3293. The proposed observations will spatially map Lyman alpha, escaping ionizing radiation, and the non-ionizing UV spectral slope, on spatial scales never before obtained for an extreme emission line galaxy. Combining this new spectrum with a published HST-WFC3 G141 grism of Ha will produce maps of Lya escape fraction and ionizing photon escape fraction, to reveal how Lyman alpha and ionizing photons are able to escape. This target has the extremely strong rest-frame UV and optical emission lines that are a hallmark of galaxies at the epoch of reionization (z~7--8), but due to lensing magnification, can be studied at very high spatial resolution. The target has a wealth of published data including HST multiband imaging, a lens model, and MMT, Keck, Gemini, and HST spectra, and is an approved target for JWST imaging and spectroscopy with NIRCam, NIRSpec, and MIRI, with all data to go public as they are observed.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16751
Program Title:	Spatial and Temporal Variations in the Physical Conditions of Clouds Shocked by the Vela Supernova Remnant

Principal Investigator:	Adam	Ritchey
PI Institution:	Eureka Scientific Inc.	

The Vela supernova remnant (SNR) is an ideal laboratory for studying the physical processes associated with SNR evolution in a highly inhomogeneous interstellar medium (ISM). Previous UV and optical absorption-line studies have revealed the remarkable nature of the highly disturbed interstellar gas interacting with the Vela SNR. The most noteworthy features are (1) the high positive and negative velocity absorption components seen in numerous directions, (2) the strong absorption from excited fine-structure levels of neutral carbon detected in low and high velocity gas, and (3) the many different absorption components that exhibit significant ongoing temporal variations. However, our understanding of the cloud-shock interactions taking place in the Vela region is far from complete. Here, we propose the first large-scale systematic investigation of shocked gas in the Vela SNR to employ the high resolution, high sensitivity, and extensive wavelength coverage provided by HST/STIS. We will observe eight stars clustered along a ridge of high pressure gas near the western edge of the northern X-ray bright region in the Vela SNR. The high resolution and broad wavelength coverage of the STIS spectra will allow us to examine the radial velocities, gas densities, thermal pressures, ionization fractions, and dust depletions in individual clouds along each line of sight. Five of our targets have archival STIS and/or GHRS observations, which will allow us to determine how the physical conditions have changed over time. The result will be the most comprehensive analysis to date of spatial and temporal variations in the physical conditions of clouds shocked by the Vela SNR.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16694
Program Title:	Confirming the first outbursting AM CVn in a globular cluster

Principal Investigator:	Liliana	Rivera Sandoval
PI Institution:	University of Alberta	

AM CVns are double white dwarf binaries with orbital periods ~5-65 mins. They have been predicted to exist in large amounts in globular clusters due to stellar interactions, but while binaries harboring neutron stars and even black holes have been previously identified, no single AM CVn has ever been confirmed to reside in any Galactic globular cluster. We propose to use 8 HST orbits to obtain FUV photometry and determine the sub-hour orbital period of a recently detected, He-rich, accreting binary in the globular cluster 47 Tuc. The system has multiwavelength characteristics that match well those expected for AM CVns. The confirmation of a sub-hour period, as expected for AM CVns, has profound implications for the dynamical evolution of globular clusters and whether they might be factories of SN Ia and ultracompact binaries that emit gravitational waves.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16752
Program Title:	The composition of exoplanetary bodies - as probed in accreting white dwarfs with gaseous emission

Principal Investigator:	Laura Rogers
PI Institution:	University of Cambridge

As we move into an epoch of rocky planet detection, white dwarfs that have accreted exoplanetary bodies are unique laboratories to directly study the bulk composition of exoplanetary material and deduce the geological processes in exoplanets. Gas and dust observed close to the white dwarfs trace the accretion of this planetary material into the atmosphere of the white dwarf. The recent three-fold increase in the number of known white dwarfs with gaseous emission (including emission features from O, Na, Mg, Si, Ca, Fe) provides a unique opportunity to study the composition of planetary material in two ways. Abundances can be derived from the gas exterior to the white dwarf, and they can then be compared to the abundances determined from the accreted material in the photosphere of the white dwarf. We propose to obtain abundances of the accreted exoplanetary material from FUV spectra of four recently discovered, heavily polluted white dwarfs with at least O, Ca, and Fe in circumstellar gaseous emission. By comparing the composition of the circumstellar gas with the composition of the material that has accreted onto the atmosphere of the white dwarf, we can probe whether volatiles are accreted simultaneously with refractories. This is crucial to using the observed abundances in the white dwarf photosphere to probe the volatile content of exoplanetary bodies, and to understand how planetary bodies lose (gain) volatiles.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Supermassive Black Holes and AGN
ID:	16765
Program Title:	Is the supermassive black hole binary candidate J0950+5128 actually a single perturbed accretion disk?

Principal Investigator:	Jessie	Runnoe
PI Institution:	Vanderbilt University	

We propose UV spectroscopy of the supermassive black hole binary (SBHB) candidate J095036+512838 (J0950) to test the alternative scenario that it harbors a perturbed accretion disk around a single black hole. By analogy to spectroscopic binary stars, this object was originally selected as a SBHB candidate by virtue of the ~1300 km/s blueshift of its broad Balmer lines relative to the rest frame set by the narrow lines. According to new spectroscopic monitoring of the radial velocity curve, J0950 recently passed conjunction and is consistent with a SBHB with a period of order decades. This is an extremely strong indication of binary motion that no other candidate has shown before, making J095036 the strongest candidate of its class. The radial velocity curve also conclusively rules out the hypothesis that this is a recoiling black hole. We will observe the Ly-alpha and C IV broad lines to discriminate between the SBHB hypothesis and the single, perturbed accretion disk hypothesis. In the former scenario the UV lines are expected to be offset in velocity just as the optical Balmer lines while in the latter they are expected to be centered at the redshift of the narrow optical emission lines.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16695
Program Title:	Cloudy mornings and clear afternoons: mapping atmospheric dynamics at the limbs of an exceptional hot Saturn

Principal Investigator:	Zafar Rustamkulov
PI Institution:	The Johns Hopkins University

Two decades of modeling and observations have revealed hot Jupiter atmospheres to be incredibly dynamic worlds, with extreme circulation patterns, strong day-night temperature contrast, and complex cloud feedback processes. While much of our understanding of hot Jupiter atmospheres is derived from information-rich transmission spectroscopy with HST, such observations spatially blend the inhomogeneous atmosphere, introducing strong biases to the retrieved mean molecular weight, temperature, and molecular abundances. Spatial, vertical, and even temporal aerosol inhomogeneities compound these uncertainties, further complicating our interpretations of traditional, blended transmission spectra. Observations that can spatially resolve both the morning and evening terminators are therefore extremely valuable to illuminate a deeper, more holistic portrait of a hot Jupiter's atmosphere with less degeneracy. We propose to measure NUV-to-IR transmission spectra of both terminators of a highly exceptional target to measure each limbs aerosol properties, temperature, and chemical abundances in order to trace its dynamics. Our proposed observations will be sensitive to even subtle differences between the limbs, providing an entirely novel and unprecedented dataset which can be used to test models of atmospheric dynamics, aerosol formation, and radiative processes.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16685
Program Title:	Low Mass Evaporating Planets: A Search for the Star-Planet Interaction in Kepler-535

Principal Investigator:	Raghvendra Sahai
PI Institution:	Jet Propulsion Laboratory

Exoplanet-host stars with planets at short separations can influence each other (commonly termed the star-planet interaction or SPI), via a variety of mechanisms. Understanding SPI in exoplanet host stars is thus crucial for understanding the evolution of both the planet and its host star, but observational evidence for SPI is generally scarce. An important signature of SPI is UV emission, and time-resolved FUV spectroscopy with HST/COS has provided compelling evidence for, and details of, the SPI phenomenon in HD189733, which has a Jupiter-mass planet.

We now propose to search for SPI in the exoplanet host star Kepler-535, which hosts a 0.21 Jupiter-radius (Rjup) planet. Our search is motivated by an intriguing new result that we have found using GALEX data: stars in which the innermost planet has a radius less than about 0.4 Rjup are statistically much more likely to have high FUV/NUV flux ratios, compared to those where the radius is significantly larger. We hypothesize that this is because it may be easier to get mass-loss from the atmosphere of Neptune and sub-Neptune mass planets as a result of irradiation by the star. When material from this evaporated mass falls onto the star, it gets heated to high temperatures (~50,000K) as has been been observed in HD189733. The high temperature plasma results in a high FUV/NUV ratio. We propose to use COS spectroscopy of diagnostic FUV lines that can effectively probe the amount of mass evaporating from the planet, and help in determining the dynamics of the gas around the planet. The results from this study will enable testing state-of-art MHD models of such systems.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16696
Program Title:	A dormant black hole or a stripped Helium star in a massive binary system

Principal Investigator:	Hugues Sana
PI Institution:	Katholieke Universiteit Leuven

The quest for dormant stellar-mass black holes (BHs) in massive binaries (i.e., OB+BH systems) is raging. All the candidates proposed so far have been heavily disputed in the weeks following their report. Combining a literature search and archival spectroscopic data with innovative analysis techniques, we have identified two promising massive binaries harboring unseen companions with masses above the BH-mass limit, and for which simulations could discard the presence of a 5Msun main-sequence stellar companion. Here we request STIS/FUV spectroscopy of the best candidate (that with the heaviest companion mass) to unveil or discard the presence of a hot, Helium stripped star as the unseen companion. A Helium stripped star would indeed contribute very little to the system optical flux, but its contribution would become more significant in the far-UV. Should the proposed observations fail to reveal such hot companion, this project will prove beyond doubt the presence of a BH, with important consequences on the evolution of gravitational-wave progenitors and the debated presence of a kick accompanying BH formation. Either outcome -- either a Helium stripped star or a dormant BH -- will result in a significant leap forward in our understanding of the evolution of massive stars, but only the FUV capabilities of HST can discriminate between both scenarios.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16697
Program Title:	Establishing the C/O gas-phase abundance scale: a critical need for galaxy evolution studies from z=0 into the epoch of reionization

Principal Investigator:	Ryan Sanders
PI Institution:	University of California - Davis

The C/O abundance ratio is a powerful probe of galaxy evolution, sensitive to gas outflows and star formation histories because carbon and oxygen enrichment occurs on different timescales. C/O has been derived for many low- and high-redshift galaxies using measurements of rest-UV OIII] and CIII] collisionally excited lines (CELs). However, C/O derived from UV CELs may be subject to an unknown and potentially large bias. It is well established that O/H determined from CELs systematically underestimates O/H based on O recombination lines (RLs; the most robust abundance determination) by a factor of ~2, known as the Abundance Discrepancy Factor (ADF). It is currently unknown whether C abundances display a similar ADF between CEL and RL methods. Consequently, we do not know whether C/O derived from UV CELs matches the true C/O value based on RLs, or is systematically biased. The primary obstacle is a lack of overlap between samples with measurements of ultra-faint optical RLs and UV CELs. We propose to measure UV OIII] and CIII] CELs in 9 HII regions with existing measurements of OII and CII RLs, leveraging the unique capabilities of HST/COS. These observations will crucially allow us to derive C/O and C/H from both CELs and RLs for the same objects, enabling a robust calibration of the C/O abundance scale from UV CELs and an understanding of the ADF of C. Securing UV spectroscopy with COS is the only feasible way to validate UV-based C/O, of critical importance to understanding rest-UV line measurements in local dwarf galaxies, galaxies at cosmic noon, and sources in the epoch of reionization with JWST in the near-future.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16734
Program Title:	Calibrating local estimators for the escape fraction of ionizing radiation 2.7Gyrs after the Big Bang

Principal Investigator:	Claudia	Scarlata
PI Institution:	University of Minnesota - Twin Cities	

The escape fraction of ionizing radiation (f_esc), a fundamental parameter in modeling of reionization, is impossible to measure at z>6. Therefore, a number of HST studies are calibrating indirect indicators of f_esc, using large samples of local galaxies (z~0.3). What is missing is a comparable sample of galaxies at the highest redshifts where all the necessary observables (covering the full spectrum from 950AA to the rest frame optical) can be measured.

We propose a coordinated HST-NOIRLab program to observe a unique sample of 8 strongly lensed Lyman alpha (Lya) emitters at 2.1<z<2.6. THese observations will enable the measurement of their escape fraction of ionizing radiation and test for evolution in its indirect estimators. WFC3 UVIS imaging will directly measure the emission at ionizing wavelengths (LyC, lambda<912AA). Longer wavelength imaging will constrain the properties of the young stars, including the dust content and the sizes of the star-forming regions. The coordinated NOIRLab Gemini observations, consisting of rest-frame UV+optical IFU spectroscopy, will provide the diagnostics required to quantify the intrinsic ionizing radiation field, nebular dust content, and kinematics of the ISM. Only the combination of the strong magnification and redshifts of these galaxies allow us to perform these measurements, probing a completely unexplored regime of physical sizes (~100s~pc) and intrinsic luminosities (~1/1000 L*UV) at z>0.5. Our sample complement planned JWST programs that are targeting the rest-frame optical for known z~3 bright emitters.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16735

Program Title: Characterizing Cold Discoveries in the Sun's Backyard

Principal Investigator: Adam Schneider

PI Institution: United States Naval Observatory Flagstaff Station

Characterizing the population of the coldest known free-floating substellar members of the solar neighborhood is now possible, giving us the opportunity to gain key insights into the efficiency of star formation at the lowest masses as well as the chemistry of high-pressure, low temperature atmospheres akin to cold, extrasolar giant planets. As individuals, each of these objects represents a unique probe into the complex chemistry present in the coldest photospheres produced in the Universe. We propose to obtain critical near-infrared F125W photometry of 12 newly discovered high proper motion, cold brown dwarfs in the solar neighborhood. The purpose of these observations is threefold: 1) to constrain each target's physical properties, 2) produce preliminary distance estimates, and 3) to provide the photometry and astrometry necessary to prepare for future spectroscopic observations. These observations will provide the vital reconnaissance needed for spectroscopic follow-up observations with HST or JWST.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16766
Program Title:	What powers the longest-rising superluminous supernova 2020abjc?

Principal Investigator:	Steve	Schulze
PI Institution:	Stockholm University	

Super-luminous supernovae (SLSNe) are rare stellar explosions whose explosion mechanism and source of immense luminosity are not well established. SN2020abjc is the longest-lasting SLSN known. Its properties are extreme, even for slow-evolving SLSNe. Its spectrum shows no sign of interaction of the SN ejecta with a circumstellar medium and its light curve (shape and colour) rejects a central engine such as a magnetar. We are thus left with the conclusion that a long-lasting light curve equals a long diffusion time, which again requires a very high total mass. The pair-instability-supernova (PISN) mechanism naturally provides both the energy source (a lot of Ni) and the long diffusion time (large mass). Could SN2020abjc be a PISN? We propose to obtain slitless near-IR spectroscopy with WFC3/IR and the G102 and G141 grisms to measure the amount of iron, sulphur, silicon and helium in the ashes of the SN progenitor. This will enable us to unveil the explosion mechanism and the progenitor of this unusual SLSN.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16717
Program Title:	UV spectroscopy of a serendipitously-detected He star in Leo A: an unprecendented glimpse of binary mass transfer at extremely low metallicity

Principal Investigator:	Peter Senchyna
PI Institution:	Carnegie Institution of Washington

Binary mass transfer likely plays an outsized role in the evolution of massive stars, yet direct empirical constraints on these processes remain elusive. In particular, stars stripped by a binary companion are among the hottest sources of ionizing radiation expected at low metallicity. Such stripped stars plausibly dominate the flux of composite stellar populations at the hardest EUV energies, and may be required to explain the puzzling high-ionization nebular emission routinely encountered in low-metallicity star-forming galaxies. But despite substantial interest and modeling effort, only one star unambiguously stripped by binary interaction has yet been uncovered and studied in-detail. Exploratory optical spectroscopy in the extremely metal-poor (<10% solar) dwarf galaxy Leo A has recently uncovered a peculiar FUV-bright star with extremely prominent optical He II emission embedded in a small ionized nebula. Preliminary NLTE atmosphere modeling confirms that this source is broadly consistent with an intermediate mass metal-poor He star stripped by binary mass transfer; yet its fundamental properties remain uncertain without spectroscopy at the FUV wavelengths where it is brightest. Here we propose COS/G160M follow-up to confirm and characterize this unique target. These observations will enable confident measurement of the luminosity, temperature, and mass of this likely stripped star as well as strong constraints to be placed on its wind velocity structure and mass loss rate. The serendipitous discovery of this object represents an unexpected and extremely timely opportunity for HST to directly observe a product of binary evolution at unprecendentedly-low metallicity.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16777
Program Title:	Deciphering the Formation History of Omega Cen with a Comprehensive Stellar Kinematic and Population Dataset

Principal Investigator:	Anil	Seth
PI Institution:	University of Utah	

Omega Centauri appears to be the stripped nucleus of one of the largest satellite galaxies that has fallen into the Milky Way. Yet the formation history of Omega Centauri is poorly understood due to the complexity of its stellar populations. We propose to obtain WFC3/UVIS imaging to measure proper motions and use UV photometry to constrain stellar abundances and ages for hundreds of thousands of stars within Omega Centauri's effective radius. In combination with a MUSE spectral mosaic that will provide star-by-star metallicity and radial velocity measurements, we will create and publicly release an unprecedented catalog of 3-D stellar velocities, age estimates, and abundance information. This combination of kinematic and stellar population information will enable us to study the details of both how and when Omega Centauri formed. These results will provide insight on the galaxy in which Omega Centauri formed and its interaction with the Milky Way, and will serve as a template for understanding the formation and tidal stripping of nuclear star clusters.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16662

Program Title: Lyman-alpha Observations of a z=8.45 Powerful Radio Galaxy

Principal Investigator: Nicholas Seymour

PI Institution: Curtin University

Powerful radio galaxies have been unique probes of the distant Universe for many decades. This proposal requests WFC3 G141 grism with F140W pre-imaging observations to confirm an emission line observed at 1.15 microns. A high continuum flux longward of this line (seen with the G141 grism and broad-band photometry) would confirm that this line is Lyman-alpha and hence this radio galaxy at z=8.45. This detection would be the most distant super-massive black hole (SMBH) and active galactic nucleus (AGN) known. At this redshift the radio galaxy would lie at the centre of a highly ionised Stromgren sphere with contributions to the ionising flux from the accretion onto the SMBH, inverse Compton emission from the jets, and star-formation. As well as reaffirming the redshift of the host and challenging models of black hole formation, these observations will potentially reveal the complex interaction of this radio-loud AGN with its local environment. Furthermore, confirmation of the existence of a luminous radio galaxy within the Epoch of Reionisation would allow studies of neutral hydrogen from absorption of the 21 cm line. Due to the transmission of the Earth's atmosphere at 1.15 microns, this observation would take >40 times longer if conducted from the ground (eight times longer if the spectrum is binned to the resolution of the G141 grism).

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16736
Program Title:	A Comparative Study of Planetary Atmospheres in Low-Metallicity Environments

Principal Investigator:	David	Sing
PI Institution:	The Johns Hopkins University	

HST has completed a number of surveys for a wide range of exoplanets, enabling comparative planetology. In the dozens of planets studied thus far, clouds and hazes have been found to be prevalent, and are seen to hide spectroscopic features. The atmospheric properties of giant planets are expected to vary substantially as the compositions of their host stars change, and a host star's metallicity should be an excellent proxy for the composition of the protoplanetary disk from it formed. Giant planets which formed in sufficiently metal-poor environments should in principle show marked differences in their atmospheric properties. In particular, planets around metal-poor stars should have preferentially clearer atmospheres and stronger molecular features, as there is less refractory elements such as Mg or Fe to make condensate clouds. The gas-phase chemistry will also change as key volatile ratios like C/O change. However, to date no hot Jupiters orbiting metal-poor stars ([Fe/H] < -0.3) have been targeted by HST, with the vast majority found in metal-rich environments. Our program takes the next steps in comparative exoplanetology, targeting exoplants with reliably low stellar metallicities down to a new metal-poor extreme ([Fe/H] < -0.49). This will provide the very first comprehensive atmospheric constraints for planets around metal-poor stars, which can then be compared to the plentiful metal-rich sample. A detailed comparison of stellar abundances to the spectral features as seen in the planet could reveal correlations that provide new insights into the atmospheric chemistry of hot Jupiters, and new insights into the nature of the planet-star metallicity connection.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16649
Program Title:	The final word on SN 2009ip: is it dead?

Principal Investigator:	Nathan	Smith
PI Institution:	University of Arizona	

We propose 10 yr post-explosion UV/optical imaging of the remarkable transient SN 2009ip, in order to determine its ultimate fate. This object was discovered in a non-terminal eruption in 2009, and then appeared to explode in a much more extreme supernova (SN)-like event in 2012. A very massive (80 Msun) quiescent progenitor was identified in an archival HST image, and the star had several luminous blue variable (LBV)-like eruptions before 2012. Many SNe IIn are inferred to have LBV progenitors to make their dense circumstellar material (CSM), but SN2009ip is an extraordinary case where the LBV-like progenitor was detected directly, and where spectra of numerous pre-SN eruptions were obtained. No other SN has this treasure trove of detailed information about the progenitor (not even SN1987A). This was one of the most important transient events of the past decade, because if it was a true core-collapse (CC) SN, then it is the first definitive case of a very massive star above 30 Msun that went SN and didn't collapse to a black hole. However, the interpretation of SN2009ip as a true CCSN is controversial for 2 reasons: (1) its lightcurve could also be explained by shell collisions from non-terminal explosive transients, and (2) the tell-tale signs of nucleosynthetic products, if present, were largely masked by CSM interaction. As with all SN progenitor candidates, proof that the star is dead requires that it disappear in late time data. Five years ago the source was only marginally fainter than the progenitor and apparently still fading. Cycle 29 will be 10 years since explosion. Our proposed observations will determine once and for all if the progenitor is gone.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16737
Program Title:	Internal Proper Motion Kinematics of Dwarf Spheroidal Galaxies: Constraining the Density and Properties of Dark Matter

Principal Investigator:	Sangmo Sohn
PI Institution:	Space Telescope Science Institute

Determination of the mass density profiles of dwarf galaxies (and specifically whether there is a central core or cusp) provides a critical test of both the properties of dark matter (DM) and the physics of cosmological structure formation. The nearby classical dwarf spheroidal galaxies (dSphs) of the Milky Way yield some of the best dynamical constraints. While large line-of-sight velocity datasets exist (some thousand stars per galaxy), interpretation is hindered by the well-known mass vs. velocity-anisotropy degeneracy of stellar dynamics. This can be resolved with proper motion (PM) measurements that yield 3-D velocity information. This is beyond the reach of Gaia, given the small velocity dispersions of dSphs and the absence of bright stars. HST is the only observatory that can advance this problem, given its combination of photometric depth, high spatial resolution, and long time baselines. We propose to obtain HST imaging of five previously imaged fields in the nearby Draco and Sculptor dSphs, to obtain high-accuracy PMs for thousands of stars in these galaxies. This provides a direct determination of their velocity anisotropy profiles, and combined with dynamical models, tightly constrains the slopes of their DM density profiles. The results will give unique constraints on both the nature of DM, and the physical mechanisms that shape DM density profiles in galaxies. No comparable measurements exist to date. The proposed program therefore shows how HST can still be used, after 30 years in orbit, to tackle unanswered fundamental questions in astrophysics.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Solar System Astronomy
ID:	16663
Program Title:	Spectroscopic diagnosis of changing back yard giant exoplanets.

Principal Investigator:	Lawrence	Sromovsky
PI Institution:	University of Wisconsin - Madison	

Uranus and Neptune, similar in size to the most abundant class of exoplanets, have been undergoing temporal changes, the causes of which we propose to investigate by measuring the informative spectral features of methane, which has special diagnostic significance on these ice giants because it can condense in their cold atmospheres. Condensation makes methane's local abundance a function of vertical and horizontal atmospheric motions and thus serves as an important constraint on models of such motions. Prior HST/STIS observations of Uranus in 2002, 2012, and 2015 have revealed that both polar regions have been depleted in methane. But a subsequent and continued dramatic brightening of its north polar region raises questions about the relative roles of aerosols and methane in producing this change, an issue which new STIS observations can resolve. STIS observations of Neptune in 2003 suggest a methane depletion similar to that of Uranus, but one sample does little to constrain whatever seasonal changes may be present. We thus propose 8 STIS orbits to obtain spatially resolved 524-1027 nm image cubes of both planets. These capture an important spectral region near 825 nm where methane and hydrogen absorptions are competitive and thus constrain the mixing ratio of methane relative to that of the dominant gas (hydrogen). They also capture a wide range of methane band strengths to help constrain the vertical distribution and scattering properties of aerosols, especially aided by the additional constraint of center-to-limb variations. HST provides a combination of wavelength coverage, spatial resolution, and stability not available from any other facility.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16677
Program Title:	Massive Stellar Populations at Reionization Metallicities: Anchoring Stellar Population Models for the JWST Era

Principal Investigator:	Daniel	Stark
PI Institution:	University of Arizona	

The first glimpse of the spectral properties of z~7-10 galaxies has emerged in the last several years. Deep UV spectra have revealed intense emission from nebular CIII] and CIV, implying a hard radiation field that is rarely seen at lower redshifts. Unfortunately, we are currently completely unprepared to interpret these features, owing largely to shortcomings in our understanding of the low metallicity stellar populations thought to power this line emission. Fortunately, HST/COS has uncovered a sample of nearby metal poor galaxies with UV nebular line spectra approaching those seen at z>6. The discovery of these galaxies opens the door for a comprehensive investigation of the low metallicity stellar populations that likely dominate at z>6. Here we propose to obtain ultra-deep (6 orbit) COS/G160M spectra capable of measuring stellar photospheric and wind absorption features in a sample of 9 metal poor galaxies with intense CIV and CIII] emission. The data will provide quantitative constraints on the metallicity of the massive stars required to power the hard radiation fields, establishing the best empirical baseline for interpreting reionization-era spectra. The proposed sample size is chosen to reveal how the ionizing spectrum varies with stellar metallicity and age in the parameter range expected at z>6. For each galaxy, we will simultaneously fit the stellar absorption features and nebular lines, providing a powerful stress test of low-metallicity models for massive stars. If this UV spectral database is not obtained while COS is still functioning, the interpretation of reionization era galaxy spectra will be severely jeopardized throughout the JWST era.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Large Scale Structure of the Universe
ID:	16738
Program Title:	Identifying gamma-ray bursts at very high redshifts

Principal Investigator:	Nial	Tanvir
PI Institution:	University of Leicester	

Gamma-ray bursts are bright enough to be seen to great distances and their afterglows can provide redshifts and positions for their host galaxies, and in some cases details of the ISM and the IGM close to the burst, even for very faint hosts that are otherwise undetectable. Thus GRBs, despite their small numbers, offer a unique and powerful tracer of early star formation and the galaxy populations in the era of reionization. Efforts to identify high-z GRBs have been rewarded with the discoveries of several GRBs at redshifts z>6.5. However, it remains the case that some good high-z candidates cannot be followed up quickly or deeply enough with ground-based IR spectroscopy, and indeed for others the Ly-a break may fall in regions of the IR spectrum difficult to access from the ground. GRB 090429B is an example, which had a photo-z of 9.4, but for which spectroscopy was curtailed due to bad weather. WFC3/IR on HST can obtain redshifts based on the location of the Ly-a break via slitless grism spectroscopy to considerably deeper limits (and hence later times) than is possible from the ground, thus offering a solution to this problem. This proposal aims to build the sample of z>6.5 GRBs by obtaining spectroscopy for up to two candidates for which photometry suggests a very high redshift, but where the redshift could not be secured from the ground. This will provide an important legacy of host galaxy targets with known redshifts for study with next generation facilities. The low rate of z>6.5 GRBs leads us to request a long-term ToO program, spanning cycles 29 and 30; where in cycle 30 we will benefit from triggers being supplemented by those from the new SVOM satellite.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16767
Program Title:	A Family Portrait of the O Stars in the Extremely Metal-Poor Galaxy Sextans A

Principal Investigator:	Grace	Telford
PI Institution:	Rutgers the State University of New Jersey	

Low-metallicity massive stars may have reionized the universe at z > 6. Yet, their contribution to the ionizing photon budget remains unconstrained and can only be estimated from stellar models. The predicted ionizing flux is highly sensitive to theoretical mass-loss rates and metal opacities, but these have never been observationally determined below the metallicity of the SMC (20% solar). Observations of individually resolved, metal-poor O stars spanning a range of masses and evolutionary stages are needed to determine the contribution of high-redshift galaxies to cosmic reionization.

Sextans A is the only nearby dwarf galaxy substantially more metal-poor than the SMC that hosts more than a few known O stars. Five have already been observed by COS and two more will be observed by ULLYSES, but these do not sample the full range of spectral types and luminosity classes. We propose new G130M and G160M COS observations of two late-O (super)giants that sample new parameter space. For the first time at 6% solar metallicity, the combined new and archival COS data will enable us to (1) empirically determine the photospheric metal opacities that set ionizing photon production; (2) measure mass-loss rates as a function of spectral type to improve the purely theoretical mass-loss prescriptions that underlie stellar evolution models; and (3) produce new stellar spectral templates tailored to the FUV observations that will be ideally suited to modeling the ionizing spectra of galaxies during the epoch of reionization. The proposed observations are urgently needed to interpret upcoming JWST campaigns at high redshift and can only be done with HST/COS.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16664

Program Title: A repeating fast radio burst in a globular cluster at 3.6 Mpc

Principal Investigator: Shriharsh Tendulkar

PI Institution: Tata Institute of Fundamental Research, Bombay

The repeating fast radio burst (FRB) 20200120E has been localized with 100 mas precision using the European VLBI network to a globular cluster (GC) in the halo of M81, a spiral galaxy at a distance of 3.63 Mpc. The proximity of the source lends itself to detailed analysis of the FRB's environment as in the case of FRB 180916 (at a distance of 150 Mpc). GCs are known to be a hotbed of stellar interaction as proven by the presence of large populations of millisecond pulsars, low mass X-ray binaries and catacylsmic variables. However, the presence of FRB 20201020E in an low metallicity, old stellar population GC is surprising compared to the locations of most other FRBs near star forming regions and the theoretical expectations of FRBs originating from extremely active neutron stars that are typically found in such star forming regions. We request a short WFC3/UVIS observation of the GC to measure its stellar density profile, compactness, dynamic state (i.e. whether it has undergone core-collapse) and perform precise astrometry with respect to the radio reference frame to localize the FRB within the GC.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16768
Program Title:	Supernova 2020wnt: a pair-instability explosion in our backyard?

Principal Investigator:	Samaporn	Tinyanont
PI Institution:	University of California - Santa Cruz	

We propose for one orbit of WFC3 UVIS/IR imaging, and one non-disruptive ToO orbit of WFC3 IR grism spectroscopy of a nearby superluminous supernova (SLSN) 2020wnt to discern whether it is a pair-instability (PI) SN. PISNe are the theoretical death of a 140-260 solar mass stars, and they may be a dominant contributor to nucleosynthesis in the early universe. A direct observation of a bona fide PISN does not yet exist in the literature. SN 2020wnt is the best candidate for a PISN yet discovered. It has a long rise from a large ejecta mass (~60 Msun) to a peak luminosity of -20.5 mags; both consistent with some PISN models. The light curve declines post-maximum with a rate of 0.01 mag/day, consistent with the radioactive decay of Co-56. Lastly, latest near-IR spectrum shows shows features associated with Fe-group elements. These features point to an explosion that produces a copious amount of nickel, like a PISN. Our imaging observations will (i) determine whether the SN is still bright enough for the grism observations and (ii) probe the host properties local to the SN site. If the SN is brighter than 22 mags in the F140W filter, we will trigger a non-disruptive ToO to obtain grism spectroscopy. The particular lines we aim to observe are the [S I], [Si I] and [Fe II] line complexes around 1.1, 1.25, and 1.6 micron. The nebular spectrum will measure the nucleosynthetic yield of the SN, and unambiguously determine whether SN 2020wnt is a PISN or other more common deaths of a massive star.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Solar System Astronomy
ID:	16720
Program Title:	A combined HST and JWST study of the composition of the faintest trans-Neptunian objects: Testing hypotheses for the formation of the Solar System

Principal Investigator:	David Trilling
PI Institution:	Northern Arizona University

The outermost region in our Solar System retains the most pristine signatures of planetary system formation and evolution. This trans-Neptunian region and its inhabitants (trans-Neptunian objects, or TNOs) therefore offer some of the best records of the earliest stages of the formation of our Solar System. There are two very different theories for how the outermost Solar System formed and evolved, and the color distribution of very small TNOs is the diagnostic key to discriminating between these two models. We propose here 99 HST orbits to address this outstanding question in planetary system formation. We will use WFC3 and ACS in a coordinated parallel program to map most of the footprint of a JWST TNO discovery program. TNO colors will be derived by combining our HST photometry with photometry from that JWST program. We will measure the colors of at least 15 TNOs as small as 10 km and will provide a definitive test of current models of the evolution of the outer Solar System. The HST observations must be made simultaneously with the JWST observations to derive both TNO colors and parallaxes. This program can only be carried out with HST, and only by combining data from both HST and JWST. The result from this program will have broad implications across multiple fields of astronomy and showcase the unique joint capabilities of NASA's premier observatories. No other facility is capable of such sensitive measurements, and this program leverages a significant investment of allocated JWST time.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	16678
Program Title:	Far-UV spectroscopy of 22 early-type galaxies: testing for IMF variation and a legacy dataset

Principal Investigator:	Pieter	van Dokkum
PI Institution:	Yale University	

The question whether the stellar initial mass function (IMF) is universal or varies with galactic environment is one of the most vexing in all of astrophysics. In the past decade there has been a particular focus on the centers of massive early-type galaxies, as studies of gravity-sensitive absorption lines and kinematics have found evidence for an excess of low mass stars in these regions compared to the IMF of the Milky Way. We propose to test this hypothesis by measuring the average chromospheric activity of stars in the centers of 22 dust-free early-type galaxies spanning a wide range of masses, ages, abundances, and spectroscopically-derived IMFs. The chromospheres of M dwarfs are very active, as has been well-established in the context of the habitability of orbiting planets, and the average level of activity in a stellar population is a strong function of the prevalence of these stars. The dominant chromospheric emission line is Ly-alpha, which we can measure using the G130M grating of COS. If the IMF varies from galaxy to galaxy we expect to see a correlation between the strength of Ly-alpha and the strength of gravity-sensitive absorption features. The program uses the same instrumental setup as was used for observations of two early-type galaxies in Cycle 27, and an analysis of those observations shows that the measurements are feasible. The proposed spectra will have substantial long-term value beyond this primary aim. The Cycle 27 data appear to be the highest quality far-UV spectra of early-type galaxies ever taken, and the full sample will constitute a legacy spectroscopic dataset of HST that complements the many orbits of archival imaging of these galaxies.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Supermassive Black Holes and AGN
ID:	16698
Program Title:	The Impact of Radio-Mode Feedback on the Circumgalactic Medium of Centaurus A
Principal Investigator:	Sylvain Veilleux
PI Institution:	University of Maryland

The iconic radio galaxy Centaurus A is the nearest example of radio-mode AGN feedback in action. Gas accretion onto the central supermassive black hole has powered multiple cycles of jet- and wind-driven outflows that span 10 orders of magnitude in physics scale from the milli-parsec radio jets and ultra-fast X-ray wind to the mega-parsec scale radio structure. Yet we still do not know if this giant radio structure is affecting the thermodynamic state of the circumgalactic medium (CGM) enough to prevent future star formation in this galaxy, as predicted by cosmological hydrodynamical simulations of massive galaxies. Here we propose high-S/N COS FUV spectroscopy of four newly catalogued FUV-bright background QSOs with projected distances of 130-150 kpc from Cen A to directly probe the radio structure of Centaurus A for the first time. These data will be combined with archival data of similar quality on QSOs with projected distances of 270-510 kpc (which will be used as control sight lines outside of the radio structure) to probe the covering fraction, kinematics, ionization, relative metallicity, and multi-phase nature of the CGM using a diverse set of diagnostics (Si II, Si III, Si IV, O I, and C II). These data will provide new insights into the process of radio-mode feedback and new tests for current and future models.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Supermassive Black Holes and AGN
ID:	16699
Program Title:	Constraining the emergent EUV ionizing emission in the reawakening monster in Mrk 590

Principal Investigator:	Marianne Vestergaard
PI Institution:	University of Copenhagen, Niels Bohr Institute

After a 10-year hiatus, Mrk 590 has rekindled its nuclear activity and is now strongly flaring in a low X-ray state. This offers a very rare opportunity to follow in real time the onset of AGN activity that can lead to better insights on the AGN central engine physics. While directly impacting galaxy evolution through energetic feedback, the AGN structure and physics are still poorly understood. We wish to catch the early onset of AGN activity to test details of AGN accretion physics that cannot be constrained in any other way.

We propose a ToO program to obtain four COS spectra of Mrk 590 at different X-ray flux levels as its AGN builds up. We will measure UV broad-line fluxes, constrain the UV and EUV ionizing continuum emission from the accretion disk, and establish the critical ionizing luminosity required for broad-line production, something that is still unknown. This allows us to test theoretical model predictions for the broad-line region physics. The efficient strategy we employ ensures that instructive constraints are obtained with a very modest HST program - yet, the full time request may not be needed. HST is the only telescope that can obtain spectra of the far-UV emission below 1900A that are crucial to reach our science goals.

By combining this HST program with observations obtained with Swift, NuSTAR, XMM and VLT we will provide a comprehensive account of the black hole accretion state changes during the early onset of AGN activity as the AGN builds up. These HST/COS data will contribute with unique information to the legacy database on this intriguing object that will undoubtedly spawn new insight on AGN physics and the changing-look AGN phenomenon.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics and Stellar Types
ID:	16718
Program Title:	Atmospheric Structure and Spin Axis Alignment of an Overlooked Planetary-Mass Companion

Principal Investigator:	Johanna	Vos
PI Institution:	American Museum of Natural History	

Next-generation telescopes such as the James Webb Space Telescope and 30-m telescopes (E-ELT, TMT, GMT) will enable the era of direct exoplanet characterization studies. Based on the handful of studies to date (e.g. Beta Pictoris b, HR8799 bcde, 2M1207B, 51 Eri b), it is clear that the interpretation of future observational data relies on a thorough understanding of complex atmospheric phenomena. Directly-imaged exoplanets such as HR8799 bcde and Beta Pic b are too close to their host star to enable in-depth, time resolved atmospheric characterization, but wide orbit planetary-mass companions can be studied with current facilities in exceptional detail. We propose to obtain HST/WFC3 spectroscopic variability monitoring of a young, newly discovered companion at the planet/brown dwarf boundary to shed light on the atmospheres of young L-type objects. The proposed observations will reveal the atmospheric structures and phenomena as well as the spin axis alignment of the system to test formation mechanism.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16719

Program Title: Characterization of Unforeseen Chromospheres in Isolated White Dwarfs

Principal Investigator: Nikolay Walters

PI Institution: University College London

In a newly identified class of single, magnetic white dwarfs, an unknown energy transport mechanism powers active chromospheres, transforming their Balmer lines from absorption to emission. The temperature inversion mechanism defies conventional explanation, with the least-unlikely model invoking current loops through conducting exoplanets. However, these emission-line white dwarfs are closely clustered on the HR diagram, thus indicating an intrinsic process must be responsible, and that it occurs at a particular evolutionary stage. We propose spin-resolved ultraviolet spectroscopy of the class prototype to constrain the properties of its chromospherically active region. This is only possible with Hubble, where sensitive constraints on the temperature and emission profile of the emitting region require ultraviolet data. Optical data provide a precise rotation period and phase, with larger amplitudes toward shorter wavelengths, and the ultraviolet will further characterize the continuum, and line emission variability. Ultraviolet observations will distinguish between variability driven by the temperature or magnetic opacity of the emission region. Importantly, anti-phase behaviour is expected between the ultraviolet and optical in the case where spot temperature is the main driver of variability. These observations are crucial to our understanding of this evolutionary-activated chromospheric phenomenon, with implications for not only this whole class of stellar remnants, but for magnetic stars in general.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Large Scale Structure of the Universe
ID:	16665
Program Title:	The HST/JWST Quasar Legacy Survey: Probing the Primordial Environment of Quasars and the Topology of Cosmic Reionzation
Principal Investigator:	Feige Wang
PI Institution:	University of Arizona

We propose to obtain deep WFC3/UVIS FQ937N narrow band imaging of a sample of six quasars at z~6.7 with extant high resolution ALMA sub-mm observations and deep optical-to-infrared spectra. These quasar fields will also be observed with deep JWST/NIRCam imaging in rest-frame UV (F115W and F200W) and optical (F356W) as well as slitless spectroscopy at 3-4 um to detect the Hbeta+[OIII] lines of galaxies in the quasar fields. The proposed HST observations will detect the Lyman alpha emission in z~6.7 galaxies, and together with the JWST observations and deep optical dropout band imaging, will enable us to measure the distribution and the clustering of Lyman alpha emitters (LAEs) in the quasar vicinity and thus measure the dark matter halo mass of these earliest supermassive black holes (SMBHs). Compared with the distribution and clustering of more massive Hbeta+[OIII] emitters in quasar vicinity, we will gain insights on how the strong quasar UV radiation affects the formation of galaxies at different masses. The HST narrow band observations will detect close companion galaxies and the extended Lyman alpha halos around the quasars to pinpoint whether the fast black hole growth are triggered by galaxy merger or cold stream accretion. The combination of the HST narrow band observations and JWST observations will also provide unparalleled measurements of the Lyman alpha emitting galaxy fraction and the distribution of the Lyman alpha line equivalent width and luminosity in the highly ionized quasar vicinity and constrain the reionization topology by comparing with such measurements in blank fields without strong ionization radiation from quasar and/or overdensity of galaxies.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16686

Program Title: The Metallicity Distribution Functions of Faint M31 Satellites

Principal Investigator: Daniel Weisz

PI Institution: University of California - Berkeley

Faint M31 satellites are among the few systems that allow us to study low-mass galaxy formation physics in detail outside of the Milky Way (MW) halo. Though HST is systematically measuring the star formation histories (SFHs) and proper motions of all M31 satellites, very few faint M31 satellites have measured resolved star metallicities, due to a paucity of bright, spectroscopically accessible stars. We propose deep WFC3/UVIS F395N (Ca H & K) imaging to measure metallicities (to a precision of ~0.1-0.2 dex) for ~100 individual red giants, a number comparable to typically MW satellites, in 3 faint M31 satellites. This order-of-magnitude improvement enables the first detailed study of metallicity distribution functions (MDFs) in faint M31 satellites. As shown in MW satellites, MDFs uniquely encode the signature of baryonic processes that shape a galaxy's evolution (e.g., inflows, outflows, stripping). We will (1) characterize the MDFs for each system and compare them to each other and to MW satellites; (2) combine our MDFs with HST-based SFHs and orbital histories to constrain the baryonic processes and environmental mechanisms that shaped their evolution; and (3) publish stellar metallicity catalogs for community spectroscopic followup now (brightest stars) or with ELTs.

This program will provide new insight into the formation of faint satellites galaxies outside the MW halo. Measuring high-fidelity MDFs is only possible due to the excellent blue-sensitivity and angular resolution of HST -- no other ground- or space-based facility can acquire this data. This program will demonstrate how HST can provide MDFs for faint galaxies throughout the M31 ecosystem.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Intergalactic Medium and the Circumgalactic
ID:	16650
Program Title:	Connecting Galaxy Black Hole Mass with the State of the Circumgalactic Medium

Principal Investigator:	Jessica	Werk
PI Institution:	University of Washington	

This proposal directly addresses a missing link in the story of galaxy formation: the physical connection between feedback from a galaxy's supermassive black hole and the kiloparsec-scale gas flows that comprise the circumgalactic medium (CGM). Now well-established, the relationship between the properties of the highly-ionized CGM and a galaxy's star formation history is one of the most surprising and informative results from the last decade of HST/COS observations. Similar to the black hole (BH) M-sigma relation, such a global relationship likely reflects multi-scale feedback processes. We have assembled a novel sample of eight nearby ~L* galaxies for which the SMBHs have dynamically resolved mass measurements, and which have nine FUV-bright background QSOs close on the sky (Rproj < 130 kpc). The sample galaxies span a narrow range in stellar mass, but host SMBHs that vary in mass by nearly two orders of magnitude. COS spectroscopy of the background QSOs will establish the relationship between the cumulative feedback energy associated with long-term BH growth (as traced by the BH mass) and the content and kinematics of the gaseous halos around these systems. Specifically, we will measure CIV column densities and kinematics to test two predictions: (1) that galaxies with more massive BHs have more evacuated CGMs; and (2) that more massive BHs drive more extreme halo gas kinematics. The HST/COS/G160M observations we propose will be the first and only empirical test to constrain the existence of any such connection between long-term SMBH growth and the physical state of the surrounding halo gas.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Intergalactic Medium and the Circumgalactic
ID:	16679
Program Title:	Mainly on the Plane: Solving the Milky Way CGM Anomaly with Low-Galactic-Latitude QSOs

Principal Investigator:	Jessica	Werk
PI Institution:	University of Washington	

Either the Milky Way's ionized CGM is an outlier compared to the CGM of other L* galaxies, or our primary method used to measure its content - hundreds of QSO sightlines that pierce its halo - is fundamentally biased. The latter possibility cannot yet be convincingly ruled out because 95% of existing UV-bright QSO sightlines with archival high-resolution UV spectra lie at Galactic latitudes |b| > 25 degrees. We now have a unique opportunity to address this huge low-latitude gap in UV-bright QSO lines of sight with our proposed sample of newly discovered, rare QSOs at |b| < 25 degrees. We argue that a key requirement to determining the structure, mass, and dynamics of the CGM is understanding its distribution along the disk axis. For the first time, we will be able to use these novel Milky Way sightlines to test the latest hydrodynamical, cosmological simulations that suggest extended, ionized disk-like structures in galaxies may persist out to ~100 kpc. Our study, which will combine high-resolution HST/COS G160M spectra of these new low-|b| QSOs with > 100 high-quality archival G160M QSO spectra, is designed to address two primary questions: (1) With an unbiased view of the halo, is the Milky Way truly an anomaly? (2) Does the MWCGM show evidence for an extended, outer, ionized disk morphology, and if so, what are its properties? Finally, if we find evidence for an extended disk, it would represent one of the largest structures on the sky ever discovered, covering nearly half of the sky.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations and the Interstellar Medium
ID:	16778
Program Title:	The Panchromatic Hubble Andromeda Southern Treasury (PHAST)

Principal Investigator:	Benjamin	Williams
PI Institution:	University of Washington	

We propose to create a legacy map of the southern half of M31 in the optical and near ultraviolet (NUV). The Panchromatic Hubble Andromeda Southern Treasury (PHAST) will add ~100 million stars to M31's stellar photometry archive and cover regions of M31 that are structurally unique and more sensitive to the merger history than the northern disk mapped in the Panchromatic Hubble Andromeda Treasury (PHAT). These newly mapped regions include the intersections with M32 and the giant southern stream, the split portion of the star forming ring, and the southern bar. By providing age, metallicity, stellar mass, and follow-up kinematics, the resolved stellar photometry of these regions will be used for detailed comparisons to simulations, including star formation history and population asymmetries as well as the orbits of M32 and the giant southern stream, allowing us to distinguish between competing merger scenarios. Thus, these measurements tightly constrain models of M31's merger history and disk evolution. Furthermore, the legacy value for such observations is undeniable; M31 has been and will continue to be a centerpiece target for many NASA and ESA missions, as well as for ground-based time-domain observations that could find extremely valuable events that require HST resolution for identifying precursors. These current and future data sets cover the entire galaxy, and thus, our coverage will increase the value of all past and future M31 observations. PHAST will complete a lasting baseline data set for this high-demand target that no other current or planned facility will be able to produce.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16666
Program Title:	A deep and complete characterization of the Vega debris disk in scattered light

Principal Investigator:	Schuyler	Wolff
PI Institution:	University of Arizona	

The discovery of the Vega debris disk (the first of its kind) predates the discovery of our own Kuiper Belt by almost a decade, and yet it has never been resolved in scattered light. Systems where we can achieve au (or even sub-au) resolution hold the keys to understanding evolved planetary system architectures. At 7.7 parsecs, Vega enables one of the highest spatial resolution imaging opportunities of all exoplanetary systems. For example, its Kuiper-belt analog ring peaks at r=11" (85 au) and extends out to ~ 20" (150 au). The sharp inner edge (as seen by ALMA) indicates the presence of as yet undetected planetary companions, but remains to be confirmed with higher resolution observations. At these angular distances, the STIS coronagraph has excellent imaging contrast. Furthermore, the luminous host star provides ample flux at optical wavelengths for the dust in the system to scatter. Despite these attributes, the Vega disk has never been imaged with HST. We propose a single heritage HST program that will provide a deep and complete characterization of the Vega debris disk system. Our program is designed to image the disk components outward of 30 au to investigate the dust properties and morphological signatures of shepherding planets. Our HST observations will complement JWST GTO Cycle 1 observations of the system with NIRCam and MIRI.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16700
Program Title:	Transit Spectroscopy in the Lyman alpha Line Core with a High Velocity Star: A New Window into Atmospheric Escape

Principal Investigator:	Allison	Youngblood
PI Institution:	University of Colorado at Boulder	

H I Lyman alpha, the most sensitive probe of exoplanet upper atmospheres and escaping material, is generally unable to probe material bound to or weakly escaping from a planet because of severe attenuation from the interstellar medium in the line core. This attenuation hinders our understanding of atmospheric escape, a process likely responsible for shaping the demographics of close-in exoplanets that we observe today, as well as properties of individual exoplanets including habitability. The newly discovered warm Neptune TOI-1231b will allow us to probe the exosphere region where planetary winds are launched due to a unique property of its host star. The host star's radial velocity (+70.5 km/s) Doppler shifts the star's Lyman alpha emission and the planet's Lyman alpha absorbers out of the 100% ISM attenuation zone allowing us to see the stellar line core and use it as a backlight for transit observations. The proposed STIS transit observation of TOI-1231b will be a novel dataset on which to test the validity of hydrodynamic escape models, a set of assumptions at the underpinning of all interpretations of all Lyman alpha transit detections to date.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16701
Program Title:	Essential Ultraviolet Stellar Characterization for Cycle 1 JWST Transiting Planet Targets

Principal Investigator:	Allison	Youngblood
PI Institution:	University of Colorado at Boulder	

Atmospheric spectroscopy of an exciting array of exoplanets (warm rocky planets, sub-Neptune, and Jupiter-mass planets) will be obtained during JWST's Cycle 1. To accurately model and interpret observations of these planets' atmospheres, we must understand the high-energy SED of their host stars: FUV and NUV-driven photochemistry shapes an atmosphere's molecular abundances and the formation of hazes, EUV irradiation can erode a planet's gaseous envelope, and flares can affect long term atmospheric stability.

A number of recent surveys have used HST's UV capabilities to characterize the energetic irradiance spectra across a range of stellar masses, ages, and activity levels. While these surveys have proven invaluable for predicting photochemical tracers and evolution of an exoplanet's atmosphere, they have also shown scatter in UV irradiance properties for stars of similar type. As a result, direct UV observations remain the gold standard for understanding the effects of the stellar irradiance on a specific exoplanet. We propose to obtain temporally-resolved UV (1150-3200 A) and X-ray stellar spectroscopy of the 23 JWST Cycle 1 targets without UV characterization data in the HST archive. Our proposed observations will provide the high-energy context necessary to determine the likelihood of atmospheric formation and retention, the identification and interpretation of atmospheric chemistry, and the impacts of stellar activity on the exoplanet atmospheric stability.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16779
Program Title:	Lyman alpha absorption from the only mini Neptune with measured helium outflow

Principal Investigator:	Michael	Zhang
PI Institution:	California Institute of Technology	

TOI 560.01 is a mini Neptune orbiting a young (400-600 Myr) and nearby (32 pc) K star, the first and only mini Neptune with measured helium absorption from its photoevaporating atmosphere. We propose to observe three transits of the planet with STIS/G140M in order to measure Lyman alpha absorption from the outflow. Photoevaporation is especially interesting to probe in this regime because it predominantly occurs in the active youth of a star's life, creating the ``Fulton gap'' in radius which divides super-Earths (1--1.8 REarth) from mini-Neptunes (2--3 REarth). These observations will allow us to measure the size, shape, and kinematic structure of the exosphere, constrain the mass loss rate, and evaluate the magnitude of any visit-to-visit variability in the outflow structure. The combination of Lyman alpha and He I 1083 nm observations will provide stringent constraints on hydrodynamical models. These two wavelengths provide complementary information: Ly alpha probes high-velocity hydrogen in the tenuous outer reaches of the exosphere, while helium probes low-velocity helium in the denser part of the exosphere, much closer to the planet surface. Finally, recent TESS observations indicate that there may be another transiting planet in the TOI 560 system on an exterior orbit, although it has not yet been confirmed. Multi-planet systems are ideal for studying mass loss because the two planets share the same high-energy irradiation history and similar formation histories, making comparative planetology possible.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Exoplanets and Exoplanet Formation
ID:	16651
Program Title:	A Search for Accreting Protoplanets within Transition Disk Gaps

Principal Investigator:	Yifan	Zhou
PI Institution:	University of Texas at Austin	

Actively accreting protoplanets offer a direct view of a critical phase of planet formation and help set the initial state of planets' entropy and luminosity evolution. However, discoveries of these planets are extremely rare, with the young PDS 70 transition disk system being the only example. Recent HST observations of the few-Jupiter mass planet PDS 70 b demonstrate the WFC3/UVIS instrument's excellent performance in directly detecting the H-alpha emission from the protoplanet. This new development enables a promising strategy to search for accreting protoplanet: high-contrast imaging observations of faint stars that host gapped transitional disks. These stars are not accessible to ground-based adaptive optics.

We select ten stars that are most likely to yield planet detections and propose HST/WFC3/UVIS direct imaging observations in the F656N filter. These observations will form a high-quality point spread function library that facilitates precision primary subtraction. The processed images will be sensitive to accreting sub-Jovian-mass planets in the transitional disk gaps, and therefore, have the potential to significantly increase the number of protoplanet discoveries.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	SNAP
Scientific Category:	Large Scale Structure of the Universe
ID:	16670
Program Title:	They almost got away: a SNAPshot survey of extreme galaxy clusters at z=0.2 -0.5
Principal Investigator:	Harald Ebeling
PI Institution:	University of Hawaii

Truly massive galaxy clusters play a pivotal role for a wealth of extragalactic and cosmological research topics, and SNAPshot observations are ideally suited to identify the most promising targets for further, in-depth cluster studies. The power of this approach was demonstrated by ACS/WFC3 SNAPshots of X-ray selected MACS and eMACS clusters (at z>0.3 and z>0.5, respectively) obtained in previous Cycles. Based on these data, the CLASH MCT, Hubble Frontier Fields, and RELICS legacy programs selected 60% of their targets from these surveys.

We propose to build upon the (e)MACS legacy SNAPshot programs by extending the surveyed redshift range to z=0.2 to create a volume-complete sample of highly X-ray luminous clusters at z=0.2-0.5. Our project will, for the first time, systematically explore the most massive clusters in the hugely promising z=0.2-0.3 range, which already gave us some of the most extreme clusters and cluster lenses known, e.g., the Bullet Cluster, A1703, RXJ1347-11, and PLCK G171.9-40.7. By exploiting this barely tapped, rich resource, the proposed program will (a) identify yet more powerful gravitational telescopes for the next generation of in-depth studies of the distant Universe with HST and JWST, (b) provide tight constraints on the mass distribution within these extreme systems, (c) advance our understanding of the evolution and interactions of dark and luminous matter in cluster cores, and (d) unveil Balmer Break Galaxies at z~2 and Lyman-break galaxies at z>6 as F814W dropouts.

Acknowledging broad community interest we waive our data rights for these observations.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	SNAP
Scientific Category:	Stellar Physics and Stellar Types
ID:	16691
Program Title:	Snapshot Observations of Nearby, Recent Transients and Their Environments

Principal Investigator:	Ryan	Foley
PI Institution:	University of California - Santa Cruz	

Supernovae and other stellar explosions (SNe) play key roles in galaxy formation and enrichment. Marking a stellar death, they are critical to understanding stellar evolution. Cosmologists use SNe to measure the Universe's expansion. Some SNe produce neutron stars and black holes. For these reasons and many others, including interesting physics of the explosions themselves, understanding the progenitors and explosions of all variety of SNe is of great importance to astrophysics.

Late-time (>200 days after explosion) HST observations of SNe measure the amount of radioactive material generated in the explosion and probe the circumstellar environments of the progenitor systems at radii inaccesible through other means. These same images can be used to examine the SN environment, and from nearby stars, we can constrain the progenitor star's age. For all transients, these data reveal their late-time luminosity, constraining explosion physics and what powers them. These observations will also precisely determine the SN position, allowing future observations to search for companion stars. For SNe Iax, which are thought to not disrupt their white dwarf progenitor stars, we can detect the surviving star when leftover radioactive material forces it to the Eddington limit. Finally, late-time observations of TDEs can see the accretion disk hidden earlier.

We have assembled a sample of 75 recent, well-observed transients, that are sufficiently close that this science can be done with short HST exposures. Combined with the statistical nature of these studies, this program is perfectly matched to snapshot observations.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	SNAP
Scientific Category:	Stellar Physics and Stellar Types
ID:	16657
Program Title:	Late-time NUV Snapshots of the Lost Envelopes of Stripped Supernovae

Principal Investigator:	Christoffer	Fremling
PI Institution:	California Institute of Technology	

We propose a snapshot program to determine the occurrence rate of interaction between circumstellar material (CSM) and the ejecta of stripped supernovae (SNe IIb, Ib, Ic, SLSNe-I) using NUV imaging at >1 year after explosion. Large amounts of CSM must have been ejected by the progenitors to these SNe, so the potential for significant CSM interaction is present. However, only in very few cases have interaction signatures been identified using ground-based observations. In these cases we see H emission in late-time spectra created by the ejecta crashing into H-rich material. The reason interaction signatures are rare could be because the bulk of envelope material is ejected a very long time before explosion, or because it is unknown how or if CSM interaction with H-poor material would appear in the optical. A systematic survey in the NUV will be able to identify NUV excess from interaction regardless of the CSM composition. NUV emission from CSM has been identified in SNe Ia, but no late-time NUV survey has been carried out for stripped SNe. This NUV snapshot program targets an untargeted sample of 163 stripped SNe, and requires on average only a 30 minute duration visit per target. NUV imaging will constrain the prevalence, radius, mass and composition of CSM around stripped SNe, and will offer novel constraints on both single- and binary-star models for stripped SNe.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Stellar Physics and Stellar Types

ID: 16682

Program Title: UV Spectroscopy of Astronomical Transients through Rolling Snapshots

Principal Investigator: Andrew Fruchter

PI Institution: Space Telescope Science Institute

We are now entering an era in which large scale surveys of the sky will discover numerous transients each night. The number of targets that could benefit from HST observations on timescales of less than three weeks will easily exceed the ability of HST to schedule disruptive ToO observations. Here we propose to use a variant of snapshot scheduling that allows transients to be observed as soon as 11 days after discovery with little to no additional overhead compared to a standard snapshot program. "Rolling Snapshots" will allow us to double the number of SNe with near UV spectra in the HST archive. Our largely volume limited sample will aid in the calibration of Type Ia SNe as distance indicators, and may prove particularly useful for comparison with Type Ia SNe near the redshift limit of the LSST. These observations will allow us to break the degeneracy between temperature and metallicity in core collapse SNe, as well as probe the interaction between the violently expanding material and its surrounding medium, thus constraining the mass loss and evolutionary history of the progenitor star. Through measurements of the the line depths and chemical content of the expanding material of superluminous supernovae we will help distinguish between a central power source or interaction with the circumstellar medium dominating the emission, and in combination with ground-based observations we will obtain a complete picture of these objects -- something which is much more difficult at the higher redshifts where they are usually found. Finally, as our raw data and our reduced spectra will be made publicly available, they should provide a valuable resource to the entire community.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16642

Program Title: A legacy survey for evolved planetary systems within 100pc

Principal Investigator: Boris Gaensicke

PI Institution: The University of Warwick

In just 25 years, we went from not knowing if the solar system is a fluke of Nature to realising that it is totally normal for stars to have planets. More remarkably, it is now clear that planet formation is a robust process, as rich multi-planet systems are found around stars more massive and less massive than the Sun. More recently, planetary systems have been identified in increasingly complex architectures, including circumbinary planets, wide binaries with planets orbiting one or both stellar components, and planets in triple stellar systems.

We have also learned that many planetary systems will survive the evolution of their host stars into the white dwarf phase. Small bodies are scattered by unseen planets into the gravitational field of the white dwarfs, tidally disrupt, form dust discs, and eventually accrete onto the white dwarf, where they can be spectroscopically detected. HST/COS has played a critical role in the study these evolved planetary systems, demonstrating that overall the bulk composition of the debris is rocky and resembles in composition the inner the solar system, including evidence for water-rich planetesimals.

Past observations of planetary systems at white dwarfs were limited to biased and incomplete samples. Here we propose a legacy HST survey of all white dwarfs within 100pc identified with Gaia to answer the following questions:

* How efficient is planet formation around 2-10Msun stars?

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	SNAP
Scientific Category:	Stellar Physics and Stellar Types
ID:	16741
Program Title:	A public UV snapshot survey of type Ia supernova hosts in IFS data

Principal Investigator:	Lluis	Galbany
PI Institution:	Universidad de Granada	

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 massive 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.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Large Scale Structure of the Universe

ID: 16773

Program Title: A SNAPshot Legacy Survey of Bright Gravitational Lenses

Principal Investigator: Karl Glazebrook

PI Institution: Swinburne University of Technology

Bright and highly magnified lensed galaxies offer the best possible view of early galaxy formation at high-redshift (1<z<4). However, such sources are extremely rare. As a result high-quality lens samples are currently limited. A new sample of ~1000 bright lensed galaxies candidates has now been identified using a convolutional neural network ensemble in the Dark Energy Camera Survey and Dark Energy Legacy Survey. By observing these with HST in SNAP mode we can quickly confirm their lensed nature, provide the data needed for accurate lensed modeling, and define a key sample for spectroscopic follow-up to address numerous science cases.

This program will dramatically increase the number of known bright lensed galaxies with HST imaging, overcoming a major limiting factor and leaving a tremendous legacy value for galaxy evolution and cosmology. The sample will enable future study of the ISM and outflows in large samples of high-redshift sources, kinematic measurements with next-generation AO systems, and cosmological studies probing the nature of dark matter and fundamental parameters such as the Hubble constant.

We waive any proprietry period on this important dataset.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	SNAP
Scientific Category:	Galaxies
ID:	16758
Program Title:	Completing the picture: The globular cluster systems of field ultra-diffuse galaxies

Principal Investigator:	Michael	Jones
PI Institution:	University of Arizona	

Advances in the latter half of the past decade have uncovered the prevalence of ultra-diffuse galaxies (UDGs) across all environments, from cluster cores to the field. These galaxies are challenging to fit into our standard picture of galaxy formation and are thus of great interest to both observers and theorists. Owing to the observational challenges presented by such diffuse stellar distributions, one of the most effective means of constraining the properties of UDGs is their globular cluster (GC) systems. HST has already played a vital role in characterizing the richness and form of the GC populations of UDGs, finding that some host extremely rich and anomalously bright GC systems, as well as providing some of the first estimates of the halo masses of UDGs. However, to date all such studies have focused on UDGs in dense environments. Here we propose a snapshot imaging program with WFC3/UVIS to make the first measurements of the GC systems of bona fide field UDGs. Although more challenging to identify and confirm than UDGs in clusters and groups, field UDGs are thought to constitute a major fraction of the overall UDG population and likely represent the original formation pathway for many UDGs that subsequently fell into groups. Comparison of the GC systems of these two populations is an ideal means to test whether they have physically similar origins, but as yet we know little of the GCs in field UDGs. The proposed observations would also provide a key reference sample for numerous other works investigating the potential formation mechanisms of UDGs and other low surface brightness galaxies, which in turn may hold clues to some of the small scale problems of LCDM.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	SNAP
Scientific Category:	Large Scale Structure of the Universe
ID:	16729
Program Title:	SNAP Survey for Extremely Magnified Individual Stars

Principal Investigator:	Patrick	Kelly
PI Institution:	University of Minnesota - Twin Cities	

The galaxy population observed near cosmic noon (at redshift z=1-2) shows numerous differences from that in the nearby universe. Since we have only been able to study the integrated light of galaxies at z=1-2, however, we do not know whether their luminous stellar populations, which drive galaxy evolution, may also be distinct. Separately, the constituents of dark matter remain unidentified, and current limits would allow a small population of primordial black holes (PBHs) formed during inflation.

The Hubble Space Telescope has recently been used to find individual, luminous stars at z=1-2 that are highly magnified by foreground galaxy clusters. As a background magnified star becomes aligned with a star or remnant in the foreground cluster, its magnification and apparent brightness can change. Using the same stellar population synthesis models that are applied to interpret galaxies at z=1-2, we find that the observed microlensing events are both brighter and more numerous than expected. PBHs responsible for 1-2% of dark matter could explain the events, while revised stellar evolution models with additional blue supergiants (BSGs), which match the photometry of two lensed stars, may present an alternative.

Here we propose a SNAP program to image cluster fields that contain blue, bright giant arcs having luminous stars close the galaxy cluster's critical curve. The survey will be able to distinguish between PBHs accounting for 2% of dark matter, and an excess of luminous BSGs, some of which should always be detectable (<28 mag). We will be able to provide targets for James Webb Space Telescope spectroscopy and draw comparisons with nearby luminous stellar populations.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Galaxies

ID: 16711

Program Title: Globular cluster systems of ultra-diffuse galaxies in low density environments

Principal Investigator: Francine Marleau

PI Institution: Universitat Innsbruck, Institut fur Astronomie

As part of a systematic deep imaging survey with CFHT+MegaCam, 96 ultra-diffuse galaxies (UDGs) in low to medium density fields have been identified. This UDG dataset is among the largest sample of this type of galaxy outside of galaxy clusters. Thanks to the high image quality of MegaCam, part of their globular clusters (GCs) population can already be detected and two populations of UDGs have been identified: one with an excess number and the other with a similar number of GCs compared to normal dwarfs. This GC candidate selection method was proven reliable for a UDG in the NGC 5846 group, using HST data that sampled most of the GCLF. This most extreme UDG hosts 40 GCs and a vast dark matter (DM) halo as massive as the Large Magellanic Cloud, but is less luminous by a factor of 50, i.e., is too massive for its stellar mass. However, VLT +MUSE spectroscopy suggests that based on the stellar velocity dispersion, this UDG hosts a rather small DM halo. Many of these properties are similar to those of the UDGs NGC1052-DF2 and -DF4 which, however, appear to have over-luminous GCs. This reveals a tension between the two different paths to measure the DM mass of a dwarf. We propose a SNAPSHOT program of 70 UDGs in non-cluster environments, employing two-band ACS imaging to trace the full population of GCs 3 magnitudes below the peak of the GCLF and give us an accurate estimate of the total number of GCs. We will characterize their GC systems and test whether some UDGs host an exceptionally large number of GCs, but with a regular GCLF, or contain a population consisting of only over-luminous GCs. Both cases pose a conundrum for our undertanding of GC and galaxy formation.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	SNAP
Scientific Category:	Supermassive Black Holes and AGN
ID:	16761
Program Title:	A Tale of Two Catalogs: Revealing the cause of GAIA/VLBI quasar position offsets

Principal Investigator:	Eileen	Meyer
PI Institution:	University of Maryland Baltimore County	

Radio very-long-baseline interferometry has for many decades provided extremely high-precision (sub-milliarcsecond) astrometry, maintaining the absolute celestial reference frame used by all astronomers. Only recently, with the launch of ESA's Gaia mission, has this been matched at optical wavelengths. An analysis of more than 11890 Gaia position matches to radio quasars in the VLBI Absolute Position Catalog has revealed 12% to have significant (> 5 sigma) position offsets. The most extreme of these range from a few to several hundred milliarcseconds, and the offset distribution shows a strong anisotropy in the direction of the radio jet. This is not due to radio structure as interferometric positions refer with high precision only to the compact core or jet base. Extensive arguments presented in several publications show that the most likely origin for the offsets are bright optical jets of 100 mas extent or more, which have not previously been predicted by theory. Other potential scenarios, such as dust obscuration in the host galaxy or dual AGN are thought to be a far less likely origin, but only HST can confirm this. We propose HST snapshots of a sample of 75 carefully selected sources (expected sample of 25 observed) to test the hypothesis that significant position disagreements between two flagship astrometry programs are due to the presence of unexpectedly strong optical jet emission.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	SNAP
Scientific Category:	Stellar Physics and Stellar Types
ID:	16776
Program Title:	Cool stars with hot companions in the Small Magellanic Cloud

Principal Investigator:	Lee	Patrick
PI Institution:	Universidad de Alicante, Dpto de Fisica	

Most massive stars are born in binary systems, with 70% expected to interact with a companion within their lifetimes. The consequences of these interactions for subsequent evolutionary stages and for the endpoints of stellar evolution are still not well understood, particularly for the red supergiant (RSG) phase: the final evolutionary stage before supernova for the majority of massive stars. To improve our understanding of RSG binary systems we propose to characterise hot companions around RSGs in the Small Magellanic Cloud (SMC) using HST ultra-violet STIS spectroscopy. Using a combination of newly acquired photometric and archival spectroscopic observations, we have selected a sample of 28 of the highest probability RSG binaries in the Small Magellanic Cloud. From stellar evolutionary models and the small number of confirmed RSG binaries in the Galaxy, we expect the majority of hot companions to be either main-sequence B-type stars or binary interaction products (e.g. from the merger of higher-order multiple components). These observations allow us to characterise SMC RSG binary systems by accurately determining masses of the hot companions to break degeneracies in orbital solutions. The results of this proposal represent a significant advancement in the characterisation of hot companions to RSGs, in orbital configurations and mass ranges that will ultimately result in double compact object binary systems.

HST Cycle 29 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Stellar Physics and Stellar Types

ID: 16716

Program Title: Snapshot Survey of Historical Microlensing Events

Principal Investigator: Kailash Sahu

PI Institution: Space Telescope Science Institute

After the first microlensing events were detected in 1993, several teams began looking systematically for such events, and more than 20,000 have been detected to date. Most of them are towards the Galactic bulge. Microlensing events have been used to study a wide range of astrophysical problems, ranging from the search for extrasolar planets and black holes, to the study of stellar properties and mass functions. While the microlensing programs have led to progress in several fields, including the study of exoplanets, they have given rise to many unsolved puzzles. For example, the observed number of microlensing events suggests a much larger optical depth towards the Galactic bulge than predicted theoretically. For exoplanets, microlensing light curves only provide the planet-to-star mass ratio, and no information on the nature of the host stars. Several very short-timescale events have been detected, which are thought to be due to free-floating planets. But they can also be explained by low-mass lensing stars moving relatively quickly. Lastly, spectroscopic observations of a large sample of microlensed sources suggest that they have higher metallicity than the general bulge stars, which is unexpected and remains enigmatic.

We propose a Snapshot survey to obtain second-epoch images of ~70 historical microlensing events, in fields already observed with HST a decade or more ago. These observations will provide proper motions of all the microlensed sources. In most cases, the lens and the source will now be spatially resolved, providing the nature of the host stars of the exoplanets. Our Snapshot program will provide important clues to address all of the above problems.