Proposal Category:	GO
Scientific Category:	Solar System
ID:	14790
Program Title:	Investigating the binary nature of active asteroid 288P/300163

Principal Investigator: Jessica Agarwal

PI Institution: Max Planck Institute for Solar System Research

We propose to study the suspected binary nature of active asteroid 288P/300163. We aim to confirm or disprove the existence of a binary nucleus, and - if confirmed - to measure the mutual orbital period and orbit orientation of the compoents, and their sizes. We request 5 orbits of WFC3 imaging, spaced at intervals of 8 -12 days. 288P belongs to the recently discovered group of active asteroids, and is particularly remarkable as HST images obtained during its last close approach to Earth in 2011 are consistent with a barely resolved binary system. If confirmed, 288P would be the first known active binary asteroid. For the first time, we would see two important consequences of rotational break-up in a single object: binary formation and dust ejection, highlighting the importance of the YORP-effect in re-shaping the asteroid belt. Confirming 288P as a binary would be a key step towards understanding the evolutionary processes underlying asteroid activity. In order to resolve the two components we need 288P at a geocentric distance comparable to or less than we had in 2011 December (1.85 AU). This condition will be fulfilled for the first time since 2011, between mid-July and mid-November of 2016. The next opportunity to carry out such observations will be in 2021.

Proposal Category: SNAP

Scientific Category: Galaxies

ID: 14649

Program Title: Opening a New Window into Galaxy Evolution Through the Lens of CO-detected Shocked Poststarburst Galaxies

Principal Investigator: Katherine Alatalo

PI Institution: Carnegie Institution of Washington

New observations have challenged the model of galaxy evolution that requires the complete expulsion of the ISM for a galaxy to transform, instead showing signs that a transition-ISM feedback loop might operate. We have identified a sample of galaxies that appear to be in the process of transitioning from blue, star-forming galaxies to red, quiescent ellipticals, based on poststarburst spectra and emission line ratios from shocks. From our candidate shocked poststarburst galaxies (SPOGs), we request snapshot observations of a subsample of the 46 SPOGs with detected reservoirs of molecular gas. These CO-SPOGs are a unique population, having been selected to be in an earlier phase of transformation than traditionally-selected poststarburst galaxies. CO-SPOGs show a variety of properties, from radio emission to morphological disruptions to enhanced NaD absorption likely from AGN-driven winds. We will use B, I and H imaging on with WFC3/UVIS and WFC3/IR to (1) probe the internal stellar structures of the observed CO-SPOGs for signs of gravitational torques from minor mergers, (2) map the dust morphologies, searching for dust filaments and stellar superclusters that could point to accretion or major interaction events, provide independent constraints on the mass and column of the neutral material, and directly image dust cones from nuclear outflows (as in NGC1266). Our requested WFC3 snapshot observations of CO-SPOGs aim to understand the triggering mechanisms that have incited this transformation, as well as if, and how, the recently discovered transition-ISM feedback loop might operate, and its impact on our understanding of galaxy evolution.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14715

Program Title: Watching AGN feedback at its birth: HST observations of nascent outflow host IC860

Principal Investigator: Katherine Alatalo

PI Institution: Carnegie Institution of Washington

IC860 is a nearby IR-luminous early-type spiral with a unique set of properties: it is a shocked, poststarburst galaxy that hosts an AGN-driven neutral wind and a compact core of molecular gas. IC860 can serve as a rosetta stone for the early stages of triggering AGN feedback. We propose to use WFC3 on HST to obtain NUV, optical and near-IR imaging of IC860. We will create a spatially-resolved history of star formation quenching through SED-fitting of 7 requested broadband filters, and compare the spatially resolved star formation histories to in different positions within the underlying stellar features (such as spiral structure) that might define a narrative of how star formation is quenching in IC860. These observations will also resolve the super-star cluster sites to trace the most recent star formation. Finally, these observations will trace the mass of the outflow by building an absorption map of the dust. IC860 presents a unique opportunity to study a galaxy at an early stage of transitioning from blue spiral to red early-type galaxy, that also hosts an AGN-driven neutral wind and a compact, turbulent molecular gas core.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14681

Program Title: Tracing Galactic Outflows to the Source: Spatially Resolved Feedback in M83 with COS

Principal Investigator: Alessandra Aloisi

PI Institution: Space Telescope Science Institute

Star-formation (SF) feedback plays a vital role in shaping galaxy properties, but there are many open questions about how this feedback is created, propagated, and felt by galaxies. SF-driven feedback can be observationally constrained with rest-frame UV absorption-line spectroscopy that accesses a range of powerful gas density and kinematic diagnostics. Studies at both high and low redshift show clear evidence for large-scale outflows in star-forming galaxies that scale with galaxy SF rate. However, by sampling one sightline or the galaxy as a whole, these studies are not tailored to reveal how the large-scale outflows develop from their ultimate sources at the scale of individual SF regions. We propose the first spatially-resolved COS G130M/G160M (1130-1800 A) study of the ISM in the nearby (4.6 Mpc) face-on spiral starburst M83 using individual young star clusters as background sources. This is the first "down-the-barrel" study where blueshifted absorptions can be identified directly with outflowing gas in a spatially resolved fashion. The kpc-scale flows sampled by the COS pointings will be anchored to the properties of the large-scale (10-100 kpc) flows thanks to the wealth of multi-wavelength observations of M83 from X-ray to radio. A comparison of COS data with mock spectra from constrained simulations of spiral galaxies with FIRE (Feedback In Realistic Environments; a code with unprecedented 1-100 pc spatial resolution and self-consistent treatments of stellar feedback) will provide an important validation of these simulations and will supply the community with a powerful and well-tested tool for galaxy formation predictions applicable to all redshifts.

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14623

Program Title: A Novel Measurement of Turbulence and Bulk Flows in the Hot Halo of M87

Principal Investigator: Mike Anderson

PI Institution: Max-Planck-Institut fur Astrophysik

Decades of observational and theoretical effort have focused on understanding the velocity structure of the hot gaseous halos (T > 10^7 K) suffusing galaxy clusters, groups, and massive ellipticals. The turbulence and bulk flows in these media transport energy, mass, and metals from the nucleus into the diffuse halo, and they provide important non-thermal pressure support which is crucial to understand for accurate hydrostatic mass modeling. The Hitomi X-ray mission was intended to measure these motions in massive clusters, but it was only able to observe one system, and its calorimeter does not have sufficient resolution for lower-mass systems like the Virgo Cluster. As an alternative, we have identified a forbidden ground-state transition in highly ionized Iron -- [Fe XXI] at 1354.08 A -- which traces plasma in a narrow range around 10^7 K (1 keV). With the sensitivity and spectral resolution of COS, this line can be used to measure the velocity structure of the hot halo gas directly. In a recent paper, we examined archival COS G140L spectra of an FUV-bright filament system projected 1.9 kpc from the center of M87 and found tentative (2-5 sigma) evidence of [Fe XXI] emission. This region also has deep X-ray observations which confirm the presence of 1 keV plasma, and the expected [Fe XXI] signal from the X-ray observations is consistent with our FUV measurement. Here we propose follow-up observations using the G130M grating in order to confirm this detection and to measure the velocity structure of the line with 50 km/s precision. Observing this unique line will allow us to measure directly the turbulence and bulk flows in the hot ambient medium of M87.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14716

Program Title: DDO 68: A flea with smaller fleas that on him prey

Principal Investigator: Francesca Annibali

PI Institution: INAF, Osservatorio Astronomico di Bologna

With the Large Binocular Cameras on the LBT, we have recently discovered a stellar stream apparently connected to DDO 68, one of the most metal-poor and isolated star-forming dwarf galaxies, with a stellar mass of only 10^8 solar masses. Here we propose HST/WFC3 follow-up imaging of the stream to accurately measure, map and characterize its individual stars, in order to: a) constrain its precise distance through the red giant branch tip, and confirm its physical association with DDO 68; and b) infer the evolution of its stellar population. At DDO 68' s distance of about 12 Mpc, only HST can resolve the stream into individual stars.
We have previously obtained ACS imaging of DDO 68. Those data, which only capture a small portion of the stream, provide tentative evidence that it is indeed at the distance of the galaxy. We also used the previous ACS data to derive DDO 68' s star formation history, and combined the results with new N-body simulations which reproduce both DDO 68' s distorted morphology and the position of the stream. This analysis suggests that DDO 68 has cannibalized a ten times smaller companion.
Our proposed observations will image the full extent of the stream, and are critical for not only understanding the true nature of this structure, but may also enable us to trace it further, beyond the extent apparent in the LBT data. DDO 68 will be the least massive dwarf galaxy with direct evidence for accretion of a satellite thus far if confirmed with the proposed observations. This study will be extremely important to test the self-similarity of the hierarchical galaxy formation process at all scales.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14777

Program Title: Deciphering Quasar Outflows and Measuring their Contribution to AGN Feedback

Principal Investigator: Nahum Arav

PI Institution: Virginia Polytechnic Institute and State University

We propose to observe, for the first time, a sample of quasar outflows covering the diagnostic-rich 500-1050 Angstrom rest-frame (XUV). This program will advance the science of quasar outflows and measure their contribution to AGN feedback more than the combined HST observations of quasar outflows to date.

Using similar COS archival data of two such objects, we have published a robust case of two-ionization-phase outflow, which is the missing link between UV AGN outflows and X-ray warm absorbers. More importantly, the superb spectral diagnostics allowed us to determine the distances of these outflows from the central source, and thus their energetics. These findings demonstrate that outflows in luminous quasars have sufficient energy to fulfill the theoretical predictions of AGN feedback processes. However, to date, not a single dedicated COS observation of outflows in the XUV has been performed. An exhaustive survey of all HST and SDSS quasar spectra and a significant improvement in analysis techniques allow us now to target a sample of 10 such objects using a reasonable amount of exposure time, hence the extraordinary scientific promise of this program.

Proposal Category: AR

Scientific Category: Blackholes

ID: 14551

Program Title: The COS revolution of AGN outflow science

Principal Investigator: Nahum Arav

PI Institution: Virginia Polytechnic Institute and State University

HST/COS has opened a new discovery space for quasar outflow science. Specifically, it provides high quality FUV spectra covering the diagnostic-rich 500A-1050A rest-frame of medium redshift objects. We have published three refereed papers based on the analysis of such data that were supported by our concluded COS archive program, in which we reported: a) a new population of very high ionization outflows, b) robust cases of two-ionization-phase outflows, which are the missing link between UV AGN outflows and x-ray warm absorbers, and most importantly c) spectral diagnostics that allowed us to determine the distance of the outflows from the central source. The latter is a cardinal issue in the field as many researchers believe that most outflows are situated close to the accretion disk (~0.01 pc) while the few reliable measurements show distances of 10-10,000 pc. Therefore, every empirical distance measurement is of importance. Our archive based publication also demonstrates that quasar outflows have sufficient energy to match theoretical predictions for AGN feedback influencing galaxy evolution.

We propose to continue this successful archive program. Thus far we've analyzed about 300 COS G130M and G160M orbits of AGN observations. There are roughly 900 additional orbits that satisfy our criteria and will be available within a year. Based on our published survey, we expect that these 900 orbits will yield about 20 -30 additional very-high ionization outflows and 4-6 cases of distance and kinetic luminosity determinations, all in cosmologically important luminous-quasars.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14717

Program Title: What is Enhancing the Tidal Disruption Rate of Stars in Post-Starburst Galaxies?

Principal Investigator: Iair Arcavi

PI Institution: University of California - Santa Barbara

The search for the tidal disruption of stars by supermassive black holes (tidal disruption events; TDEs) is now yielding exciting results. Recently, we tied several events together into a coherent class of outbursts. This picture offers a surprising new insight: TDEs show a strong (200x) preference for post-starburst galaxies. Why is this? As likely post-merger galaxies, they could harbor a binary black hole in their center, which is expected to increase the rate of TDEs, but only at certain ages after the merger and for certain merger mass ratios. Alternatively, a disturbed central potential or nuclear gas reservoirs may be affecting stellar orbits in the core of the galaxy. Finally, a nuclear over-abundance of A stars (which dominate ground-based galaxy-integrated spectra), evolving to giants, could increase the global cross section for tidal disruption. HST spatial resolution and low surface brightness sensitivity allows us to test each of these options for four post-starburst TDE host galaxies. We will measure post-merger tidal tails, age-date the starburst using individual star cluster colors, map the luminosity profile of the inner ~100pc to test for asphericity or double nuclei, and localize the weak line emission and A-star population seen in our galaxy-integrated spectra. We will also perform bulge-disk decompositions to estimate the mass of the central black hole, a crucial test of TDE emission models. Our group has successfully carried out HST analyses of the star cluster populations, tidal tails, and core surface brightness profiles of (non-TDE-host) post-starburst galaxies, a sample which will serve as a control for the observations proposed here.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14624

Program Title: Taming the Flame: A Near-IR imaging study of the NGC 2024 (Flame Nebula) cluster

Principal Investigator: Hector Arce

PI Institution: Yale University

We propose to obtain HST WFC3/IR observations of the young (1 Myr) NGC 2024 (Flame Nebula) cluster in Orion. We will employ a recently developed technique to efficiently map large regions with WFC3 in order to map a ~16' x 16' (~ 2 x 2 pc) region that will cover most of the cluster in only 8 orbits. The proposed observations of the Flame Nebula will provide us with WFC3/IR (F160W) images with a resolution of ~80 AU, which we will use to: 1) determine the fraction of multiple systems and their properties in a dense and young environment for comparison to existing HST multiplicity studies of lower density environments in the Orion clouds and the denser Orion Nebula Cluster (ONC); 2) resolve the structure of disks, infalling envelopes and outflow cavities around protostars in a young cluster, and 3) measure the proper motions of stars in the cluster core. NGC 2024 is the second largest and densest cluster in Orion after the ONC. A large number of HST programs have studied the multiple systems, disks, outflows and proper motions of stars in the older (~2 -3 Myr), optically visible, ONC. With the new wide-field IR imaging capabilities in HST, it is now the time to study "ONC's younger (and embedded) cousin" NGC 2024, in order to better understand how clusters (and the stars inside them) form and evolve.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14625

Program Title: Connecting the lower and upper atmospheres of a warm-Neptune. Implications for planetary evolution.

Principal Investigator: Gilda Ballester

PI Institution: University of Arizona

The FUV transit technique specific to HST is unique at characterizing the upper atmospheres of exoplanets. Indeed, the uppermost layers of a planet orbiting close to an EUV-bright star undergo great heating, inflation and mass escape. FUV transit observations of the warm-Neptune GJ 436b have revealed an immense H I cloud with an escaping cometary tail, evidencing substantial mass loss that can significantly affect the atmospheric composition and evolution of the planet. As known to take place on hot Jupiters, the outflow of the light hydrogen-dominated escaping material can drag along heavier species. All three key atoms of H I, O I, and C II that reside in the uppermost layers have strong resonant FUV lines. Here we propose FUV transit observations of the warm-Neptune HAT-P-11b, which is the only low-mass exoplanet to have positively revealed water absorption in a relatively clear lower atmosphere, thus showing that oxygen is available in measurable amounts in its bulk atmosphere. One transit will be made with STIS/G140M and another with COS/G130M, which will measure the spatial extent as well as global velocity/energy properties in all three H I, O I, and C II atoms. With such data we can study the processes involved in the escape and space physics environment. Together with comprehensive, iterative modeling of the lower and upper atmospheres, and of the magnetosphere expected for these planets, we can gain insight into the composition and escape in the uppermost planetary regions, and into how they relate to the lower atmosphere and thus the planetary properties.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14703

Program Title: Measuring residual H2 gas from small to large gaps in protoplanetary disks: different pathways to planets?

Principal Investigator: Andrea Banzatti

PI Institution: Space Telescope Science Institute

We propose HST-COS far-ultraviolet (FUV) spectra of H_2 gas emission in a representative sample of 8 "transitional" disks around young stars of ~1-2 solar masses. By targeting 0.3-5 au disk gaps revealed from the analysis of infrared (IR) CO emission spectra, the proposed HST observations will allow us to measure the density of residual molecular gas from the onset of the smallest disk gaps to the development of large gaps that can be directly imaged. The sensitive measurements of H_2 residual gas vs disk gap size obtained in this program will constrain gap-formation processes and reveal if all gap sizes belong to a common, sequential evolutionary path or to different paths that affect the orbital distribution and composition of forming planets. This is essential to validate and improve current theories of planet formation in dispersing disks, extending observations to small disk radii well beyond the angular resolution limits of current imaging techniques. This program takes immediate advantage of recent results finding new gas emission tracers of disk evolution in the UV (Hoadley, France, et al. 2015) and in the IR (Banzatti & Pontoppidan 2015), and joins them together into a new, panchromatic view of gas dispersal in planet-forming regions.

Proposal Category: AR

Scientific Category: Galaxies

ID: 14552

Program Title: Spatially resolved UV-to-FIR SEDs of compact SFGs at z~2: Witnessing the epoch of core building

Principal Investigator: Guillermo Barro

PI Institution: University of California - Berkeley

The massive galaxy population at z~2 appears to be quite diverse, ranging from large and clumpy star-forming galaxies to compact quiescent systems. However, the origin of compact quiescent galaxies and their relation to the larger star-forming galaxies are still poorly understood. We have identified a population of dusty, compact star-forming galaxies at z~2 whose structural properties and number densities suggest an evolutionary connection with the first quiescent galaxies. But demonstrating full consistency between progenitor to descendant populations requires verifying that the candidate star-forming progenitors are truly compact in stellar mass and that their SFR is also compact and centrally concentrated (i.e., starburst) rather than distributed in a inside-out growing disk. In the proposed work we will make use of the exquisite image quality and exceptional depth of the CANDELS observations, spanning from the optical-to-NIR, in combination with novel, high-resolution imaging in the far-IR obtained with the submm interferometer ALMA at 870 microns. Together, these datasets will allow the first spatially resolved, self-consistent analysis of the stellar population and dust emission properties of compact SFGs at sub-kpc scales. Moreover, the energy balance between UV and IR luminosities will offer a more direct probe into the effects of dust attenuation, which will allow precise measurements of the physical size and overall distribution of the SFR and stellar mass. Based on those measurements we will constrain the structural evolutionary path of compact SFGs in the mass-size space to confirm if they are indeed direct progenitors of compact quiescent galaxies.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14626

Program Title: DASH Mapping of IC348: The IMF from 2 to 80 Jupiter Masses

Principal Investigator: Mary Barsony

PI Institution: SETI Institute

The young, nearby, and relatively compact IC348 cluster is an ideal target for determining the IMF in the mass range encompassing those of giant planets and brown dwarfs, since these objects are orders of magnitude more luminous upon formation than at ages found in the field. Making use of the fact that the chief opacity source in substellar atmospheres is water vapor, whose absorption strength increases with decreasing Teff, we have constructed a reddening-independent ``water index'' from three WFC3 filters, including the one which transmits the 1.4 micron water feature, capable of deriving the spectral types of sources with masses spanning those of brown dwarfs and gas giant planets. We can also derive the extinction to these sources from their locations in a color-color diagram using these three filters, thus allowing unambiguous identification of each source as a cloud member or background object, a determination not possible from ground-based broadband photometry for these low masses. Using the recently implemented ``drift and shift'' (DASH) observing mode of WFC3

allows mapping unprecedentedly large angular scales with Hubble at depths unattainable from the ground. The result of this investigation will be the largest star-formation area ever mapped capable of unambiguously identifying objects down to 1 Jupiter mass, and complete to 3 Jupiter masses, making allowance for the effects of variable extinction across the cluster.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14791

Program Title: Assessing the dependency of the fine structure constant on gravity using hot DA white dwarfs

Principal Investigator: Martin Barstow

PI Institution: University of Leicester

Variation of fundamental constants is a common theme of many theories of quantum gravity and Grand Unification. Using spectra obtained with the Hubble Space Telescope, it has been shown by Berengut et al. (2013), and Bagdonaite et al. (2014), that it is possible to place strong constraints on gravitational variations of the fine structure constant (alpha), and the proton to electron mass ratio (mu) in white dwarf stars.

As part of the UV initiative, we propose to observe four hot DA white dwarf stars using STIS with the E140H grating, totalling 12 orbits. These four stars have been chosen so as to have a wide range of masses, allowing a full exploration of the compactness parameter space (M/R). We will measure several absorption features of Fe V and Ni V, and extract any potential variation in alpha in a manner similar to Berengut et al. (2013).

This proposal will be a significant advance in the effort to detect gravitational variations in alpha. A confirmed detection of alpha variation would have extensive consequences for fundamental physics, cosmology, and would also signal the breakdown of Einstein's Equivalence principle, and hence, general relativity. Furthermore, a null detection would also allow strong limits to be placed on any potential alpha variation in a strong gravitational field.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14593

Program Title: Constraining the Origin of Multiple Populations in Globular Clusters

Principal Investigator: Nate Bastian

PI Institution: Liverpool John Moores University

Ancient Globular Clusters (GCs), once thought to be the quintessential single stellar population, are now known to host multiple populations, with varying metal (and presumably helium) content between stars. Many scenarios have been put forward to explain the presence of the multiple populations, several of which rely on multiple generations of stars, with the first generation chemically enriching further generations. Testing these scenarios is difficult as nearby young clusters, that can be resolved into their constituent stars, do not show age/abundance spreads. It has been suggested that this is the case because the young clusters are not massive enough (>5*10^5 Msun) to hold onto their stellar ejecta, and hence follow a different evolutionary path than GCs. We propose UV imaging of a sample of massive (>10^6 Msun) young (50-500 Myr) clusters, in order to combine them with our ground based medium resolution high S/N VLT/X-shooter spectroscopy (and existing HST U-band and optical imaging), to confirm or refute age spreads within them. We will be able to place limits of >10-to-1, first-to-second generation mass ratios, which will directly test popular globular cluster formation models.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14792

Program Title: Remastering the classics: A thermal inversion for the hot Jupiter archetype HAT-P-7b?

Principal Investigator: Jacob Bean

PI Institution: University of Chicago

One of the key questions raised by the Spitzer characterization of transiting exoplanets is the cause of thermal inversions in hot Jupiter atmospheres. This is a question that has motivated numerous observational and theoretical efforts to search for and explain the phenomenon over the last eight years. However, recent work by our team and others indicates that some previous claims of thermal inversion detections based on Spitzer data are ambiguous at best, and even wrong in some cases. On the other hand, new WFC3 spectroscopy data have suggested that other hot Jupiters may indeed have thermal inversions, thus reigniting an old debate.

We propose here to characterize the best remaining thermal inversion archetype suggested by Spitzer observations. We will measure the thermal emission spectrum of the transiting hot Jupiter HAT-P-7b by observing secondary eclipses with WFC3. The WFC3 spectrum will unambiguously reveal the thermal structure of the planet's atmosphere and definitely test the influential thermal inversion hypothesis.

It is of vital importantance to get to the bottom of this issue now. If thermal inversions as we have been envisioning them are a real phenomenon, then the community will want to study the question of their origin in more detail with JWST. However, if the previous claims were spurious and we continue to believe that this is a problem worth investigating, then we will be following a blind alley with early JWST observations. We have a chance to address the influential thermal inversion hypothesis today with HST, and thus to establish the best foundation for the exciting future ahead with JWST.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14793

Program Title: The First Precise Atmospheric Metallicity Measurement for a Sub-Jovian Exoplanet

Principal Investigator: Jacob Bean

PI Institution: University of Chicago

A central prediction of the core accretion model of planet formation is that atmospheric metallicity should increase with decreasing planet mass. This prediction is born out in the Solar System, where a clear anti-correlation between planet mass and atmospheric metallicity is observed. Exoplanets offer the potential to determine if this fundamental trend is a universal outcome of the planet formation process.

We have recently succeeded in measuring the atmospheric metallicities of gas giant exoplanets using HST transit spectroscopy observations. These first results offer the tantalizing suggestion that the trend seen in the Solar System is also discernable in extrasolar systems. We propose here to extend our study of atmospheric metallicity vs. planet mass in to a new regime by measuring a precise atmospheric metallicity of a Neptune-sized exoplanet. We will measure the transmission spectrum of HAT-P-11b between 0.8 and 1.1 microns by observing five transits of the planet using the WFC3 instrument and G102 grism. These observations will complement existing data between 1.1 and 1.7 microns obtained with the standard G141 grism, which show a strong water absorption feature. The unique combined dataset spanning three bands of water will enable us to break the degeneracy between clouds and metallicity that typically plague the interpretation of transmission spectra.

This project will yield the first precise atmospheric metallicity measurement for a sub-Jovian exoplanet, and will be the first to demonstrate a modeling technique that will be crucial for the interpretation of JWST transmission spectra.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14664

Program Title: Phase-Resolved Emission Spectroscopy of the Transiting Brown Dwarf KELT-1b Using WFC3

Principal Investigator: Thomas Beatty

PI Institution: The Pennsylvania State University

We propose to use 40 HST orbits to observe a spectroscopically-resolved orbital phase curve of the transiting brown dwarf KELT-1b from 1.15um to 1.65um using WFC3. KELT-1b is a 27MJ object on a short 1.217 day (29.2 hour) orbit around a bright (H=9.534) F5V star. This system is unique, in that it contains the only known highly irradiated brown dwarf on which it is possible to perform high precision atmospheric measurements. It thus gives us a chance to globally observe an irradiated atmosphere, when we know how that atmosphere should look in the absence of external irradiation. We intend to determine how irradiation affects the cloud properties and composition of KELT-1b's atmosphere, by comparing directly to observations of field brown dwarfs with a similar mass and age. We will also investigate the role surface gravity plays in setting the circulation and structure of hot Jupiter atmospheres, by comparing KELT-1b's high-gravity atmosphere to existing datasets for WASP-43b and WASP-103b. Finally, these observations will allow us to perform one of the first direct tests of brown dwarf surface gravity indicators. These observations will complement existing Spitzer observations of KELT-1b's phase curve at 3.6um and 4.5um, and an H-band eclipse spectrum that our group has already obtained from the ground.

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14718

Program Title: The Metal-Enriched Environments of Galaxies Near Reionization

Principal Investigator: George Becker

PI Institution: University of California - Riverside

The relationship between galaxies and extended metal-enriched gas offers a powerful diagnostic of the feedback processes that shape galaxy growth. Over $0 < z < 3$, significant insights into this relationship have been gained by studying the galaxies associated with quasar metal absorption lines. We can now trace metals in quasar spectra back to $z > 6$; to date, however, little work on the galaxy-absorber connection at these redshifts has been done due to the high cost of identifying the galaxies. To overcome this obstacle, we propose to obtain deep ACS and WFC3 imaging--building on archival data--in the field of a single z=7 quasar whose spectrum contains an unusually high number of intervening absorbers over $5.5 < z < 6.5$. Targeting this field will allow us to search for galaxies associated with multiple metal systems systems simultaneously, offering a high multiplexing advantage for follow-up spectroscopy. The extent to which z~6 galaxies are (or are not) associated with these metal lines, and the relationship between absorber and galaxy properties will deliver much needed insights into the mechanisms that drive galaxy growth and metal enrichment during the reionization epoch.

Proposal Category: GO

Scientific Category: Solar System

ID: 14609

Program Title: Psyche's UV Reflectance Spectra: Exploring the origins of the largest exposed-core metallic asteroid

Principal Investigator: Tracy Becker

PI Institution: Southwest Research Institute

(16) Psyche is the largest of the M-class asteroids, and is presumed to be the exposed core of a differentiated asteroid stripped of its mantle through hit-and-run collisions. However, other origins for Psyche have been proposed, including that it formed from a highly-reduced, metal rich material in the inner solar system or that its surface is olivine that has been space weathered. If (16) Psyche is an exposed core, then studying its properties enhances our understanding of the cores of all terrestrial planets, including the Earth's. If it accreted in the inner part of the solar system and was later injected into the asteroid belt, then Psyche sheds light on the conditions and subsequent evolution of the early solar system. Lastly, if Psyche is weathered olivine, then olivine may be more abundant in the solar system than currently measured, rectifying the so-called "Great Dunite Shortage". Our program to obtain high-resolution UV spectra of Psyche with the COS G140L mode and the STIS NUV MAMA G230L mode to measure spectral signatures between 90 - 315 nm is designed to distinguish between the 3 hypothesized cases. These observations will enable identification of absorption bands, especially Fe-O charge transfer bands and will be sensitive to "spectral blueing" that occurs at UV wavelengths for space-weathered objects. When combined, the presence of these UV features, or not, provides a novel test of Psyche formation theories.

Proposal Category: GO

Scientific Category: Solar System

ID: 14627

Program Title: The Lightcurve of New Horizons Encounter TNO 2014 MU69

Principal Investigator: Susan Benecchi

PI Institution: Planetary Science Institute

The New Horizons spacecraft was recently redirected to encounter the Transneptunian Object (TNO) 2014 MU69 on 1 January 2019. In order to optimally plan the fly-by sequencing, we must learn as much about this object in advance of the encounter as possible. In particular, it is critical that we determine, to the best of our ability, if the object is binary (as is the case for ~20% of cold classical TNOs in this size range), the rotation period and shape of the body. All of these parameters influence the encounter design and timing. Existing and proposed HST astrometric datasets constrain its diameter (21-41 km for an albedo of 0.15-0.04) and orbit, and suggest a rotational lightcurve amplitude of >0.3 mags, but cannot determine the rotation period or lightcurve shape. To that end we propose to use 24 HST orbits over ~4 days to measure the lightcurve amplitude of 2014 MU69, and constrain its rotation period to better than 5%. 2014 MU69's orbit identifies it as very typical member of the "cold classical" TNO population. This makes it an ideal target for our spacecraft mission because close-up observations obtained of 2014 MU69 can be extrapolated to understand the cold classical population as a whole, which is the most primitive and least disturbed part of the Kuiper Belt.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14682

Program Title: A Search for Methane, Ammonia, and Water on Two Habitable Zone Super-Earths

Principal Investigator: Bjoern Benneke

PI Institution: California Institute of Technology

The recent discovery of two transiting super-Earths in the habitable zones of bright, nearby M-dwarfs provides us with the unprecedented opportunity to carry out the first spectroscopic studies of the atmospheres of potentially habitable planets outside our solar system. The planets' equilibrium temperatures of 210-275 K and 225-305 K, respectively, are consistent with the potential presence of liquid water, a condition generally regarded as a necessity for the existence of life as we know it. Here, we propose to obtain HST WFC3 transmission spectroscopy of both planets in order to infer their atmospheric hydrogen fractions, carbon-to-nitrogen ratios (C/N), and to determine their potential habitability. Our proposed observations will cleanly distinguish between cloud-free, H2-dominated scenarios and high mean molecular mass (e.g. H2O-dominated) atmospheres. For hydrogen-rich atmospheres we can determine the C/N ratio based on the relative strengths of methane and ammonia absorption, allowing us to distinguish between H2/He atmospheres accreted from the protoplanetary disk and H2-rich atmospheres formed through outgassing. The detection of absorption from methane, ammonia, and/or water will make K2-18b and K2-3d prime targets for first-light observations with JWST to search for biosignatures in their atmospheres. Observations in HST Cycle 23 will allow us to determine the atmospheric compositions and potential habitability of these planets prior to the spring 2017 JWST GTO proposal deadline.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 14628

Program Title: The Evolution of C/O in Low Metallicity Dwarf Galaxies

Principal Investigator: Danielle Berg

PI Institution: University of Wisconsin - Milwaukee

While oxygen and nitrogen have been widely observed in spiral and dwarf galaxies, the study of the next most abundant element, carbon, remains relatively unexplored. Recently, we presented results from HST/COS observations of nebular C/O in low-metallicity dwarf galaxies based solely on simultaneous detections of the UV OIII] and CIII] emission lines. While the data are consistent with a trend for increasing C/O with increasing O/H, there are significant outliers and the small number of observations prevent the identification of a definitive relationship or a secure measurement of the dispersion.

The sensitivity and optimal wavelength coverage of COS and the large pool of spectra available today due to extensive surveys (e.g., the SDSS), allow us to efficiently increase the number of secure C/O measurements in HII regions. We propose to use COS to observe the UV emission lines of carbon and oxygen for 20 high-surface brightness low-metallicity dwarf galaxies. Combining these data with previous studies will triple the sample, allowing a statistical analysis of C/O abundances in nearby dwarf galaxies. Determining the underlying trend of C with O and the scatter in C/O at a given value of O/H provides strong constraints on the nucleosynthetic origin of C. In addition, combining these data with ground-based optical spectra will show to what degree C and N production are coupled. As the number of high redshift galaxies with C/O measurements continues to grow, due to the ease of detecting their rest-frame UV lines in the optical, firm C/O determinations at low redshifts are critical for comparison.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14757

Program Title: Hydrogen Escape from a Rocky Earth-Size Exoplanet

Principal Investigator: Zachory Berta-Thompson

PI Institution: Massachusetts Institute of Technology

Planets transiting M dwarfs offer our best opportunities to observe the atmospheres of potentially habitable planets outside the Solar System. Models predict that M dwarfs can significantly erode their planets' atmospheres, but no observations yet exist to investigate this atmospheric escape. GJ1132b is a warm, rocky, Earth-size planet transiting a star that is both very nearby (12pc) and very small (0.21 solar radii). Here, we propose to use GJ1132b as a laboratory to examine the process of hydrogen escape from terrestrial planets, a topic that is important for understanding the evolution of habitable worlds. We will use STIS to observe two transits of GJ1132b at Lyman-alpha wavelengths, to measure the size of the neutral hydrogen cloud escaping from the planet. Such a cloud might be fed by the dissociation of trace amounts of water or hydrogen halides in the planet's upper atmosphere. In a Cycle 23 pilot study, we proved the star is bright enough at Ly-alpha to serve as a backlight for these observations, and we tentatively detected a 40% flux decrement when the planet was in front the star. GJ1132b is subject to less radiation pressure than the comet-tailed exoplanet Gl436b; this allows neutral hydrogen to develop into an inflated coma and leading arm, with substantial absorption before and during the time of optical transits. These observations would provide the first constraints on atmospheric escape from an Earth-size planet around an M dwarf, and they make use of Hubble's precious UV capabilities to inform future JWST atmospheric observations of GJ1132b and other rocky planets.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14758

Program Title: The Hydrogen Content of a Rocky Earth-Size Exoplanet

Principal Investigator: Zachory Berta-Thompson

PI Institution: Massachusetts Institute of Technology

The composition of a terrestrial planet's atmosphere results from a complex interplay of accretion, escape, and outgassing. We have little data on how such processes proceed for planets around stars other than our Sun. The warm, Earth-size planet GJ1132b transits a late M dwarf and offers a unique opportunity for studying the atmospheric composition of a rocky exoplanet. Thanks to this transiting planet's proximity (12pc) and large transit depth (0.3%), possible scenarios for GJ1132b's atmospheric transmission spectrum can be observed with the Hubble Space Telescope. Here, we propose to use WFC3/IR to observe five transits of GJ1132b, to search for absorption features from a cloud-free, hydrogen-rich atmosphere. Such an atmosphere could potentially arise from late outgassing of volatiles from the planetary interior. The detection of molecular absorption in GJ1132b's atmosphere is an important step toward the long-term goal of characterizing the atmospheres of cooler habitable planets, and GJ1132b is a favorable target for JWST observations. The results of this Hubble/WFC3 investigation would inform the optimal strategy to observe GJ1132b with JWST. If we detect deep absorption features with WFC3, JWST should observe GJ1132b across its entire wavelength range. If we do not, JWST may first need to focus more intensely on smaller individual wavelength windows. This planet provides the first chance for WFC3 to study the atmosphere of an exoplanet that almost resembles terrestrial worlds in our own Solar System.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 14719

Program Title: The detailed properties of star-forming regions at high redshift: a matched-resolution HST-Halpha-ALMA study

Principal Investigator: Philip Best

PI Institution: Royal Observatory Edinburgh

Star-formation in high redshift galaxies takes place in very different conditions to those locally: high-redshift star-forming galaxies are dominated by gas-rich (f_gas ~ 20-80%) turbulent disks, have a highly pressured interstellar medium, and contain star-forming complexes orders of magnitude larger than those nearby. To understand quantitative the physical conditions and processes in these galaxies requires spatially-resolved studies of their properties and dynamics. We have been addressing this using adaptive-optics-assisted integral field spectroscopy of the H-alpha line emission of 'typical' galaxies at z=1.47 and 2.23, coupled with ALMA imaging of the thermal dust emission at matched 0.1-arcsec resolution. Here we propose to obtain two-filter HST images of 9 of these galaxies to delineate the old and young stellar populations on the same kpc-scales. Using these data we will: (i) measure spatially-resolved dust attenuation by accurately mapping the H-alpha to ultraviolet star-formation rate ratio across the galaxies; (ii) derive corrected star-formation rates, quantify the properties of the star-forming clumps, and investigate their scaling relations; (iii) critically test numerical simulations of the properties and lifetimes of these clumps; (iv) determine the morphological properties of the galaxies: evidence for mergers, disk scale-lengths, Sersic indices; (v) provide the first spatially-resolved comparison of the three classic star-formation tracers (UV, H-alpha, far-IR) at high redshift. This matched-resolution HST-Halpha-ALMA dataset will be a uniquely powerful resource for understanding the physical conditions within high-redshift star-forming galaxies.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	IGM and COS
ID:	14594
Program Title:	QSAGE: QSO Sightline And Galaxy Evolution
Principal Investigator:	Rich Bielby
PI Institution:	Durham Univ.

The average star formation rate of the cosmos shows a sharp decline between z ~ 1-2 and the present-day, such that stars are formed 30 times faster at z=1 than in the local Universe. The goal of this proposal is to relate these rapid changes in galaxies to the evolution of the surrounding gas halo predicted by theoretical models. Our aim is to build a large sample of z ~ 1 galaxies close to the best available archival STIS observed QSO sightlines, complementing smaller samples at z < 0.5 and z > 2. To achieve this we propose observations with the WFC3 G141 grism to measure the redshifts and star formation rates of 1200 z ~ 1 galaxies within 600 kpc of the STIS sightlines and cross-correlate the redshifts of the galaxies with absorption features in the QSO spectra, to identify structures in the circum-galactic medium (CGM, <300 kpc, physical) and inter-galactic medium (IGM, >300 kpc) associated with these galaxies. The efficiency of WFC3 will probe the CGM of ~ 10 times the number of galaxies of contemporary studies. These are key observations for constraining models of galaxy evolution and will allow us to distinguish between the different feedback models governing the inflow and outflow of gas using state-of-the-art cosmological hydrodynamic simulations.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14794

Program Title: Planetary Nebulae in the Open Clusters of M31

Principal Investigator: Howard Bond

PI Institution: The Pennsylvania State University

Most planetary nebulae (PNe) are field objects. Precious little is known about their progenitor stars' properties and how they relate to those of the PN. The lone exceptions are the very rare cases where a PN is a member of an open star cluster. Then one can determine the ages, masses, and compositions of the progenitors, providing direct tests of stellar-evolution theory.

We have recently discovered three PNe belonging to open clusters in M31, the Andromeda Galaxy. Here we propose a set of HST follow-up investigations.

For the PN in the M31 cluster B477-D075, we know its precise location, and there are excellent photometric data (from the M31 PHAT project) that establish the host cluster's age (350 Myr) and the mass of the PN progenitor star (3.35 Msun). We will use STIS spectroscopy in the UV and optical to measure He, CNO, and alpha-process abundances in the nebula, based on emission-line fluxes and a photoionization code. Our primary aim is to compare the measured abundances with predictions of post-AGB evolution theory. In particular, "hot-bottom burning" is expected to produce enhanced He/H and N/O abundances when the progenitor star is sufficiently massive, but it is uncertain whether this occurs at masses as low as ~3 Msun, or requires masses of at least ~5 Msun. Thus our observations will provide key new constraints on AGB evolution of intermediate-mass stars.

For two other M31 clusters, B458-D049 and SK044A, whose integrated-light spectra show that a PN is

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14683

Program Title: Before the Burst: The properties of Rapidly Rotating, Massive Supergiants

Principal Investigator: JC Bouret

PI Institution: CNRS, Laboratoire d'Astrophysique de Marseille

Rapidly rotating, evolved massive stars are thought to be the progenitors of long gamma-ray bursts (LGRBs). Their rapid rotation may be the result of (a) reduced angular-momentum loss by a single star due to reduced mass loss at low metallicity; or (b) spin-up via mass and angular momentum transfer from a companion or a stellar merger. Independent of their formation mechanism, the properties of their stellar winds are strongly affected by their rapid rotation. We have recently obtained optical spectroscopy to study the properties of a sample of ten fast rotating, evolved massive stars in the Large Magellanic Cloud. Here, we propose to use HST FUV spectroscopy to determine the wind properties of these objects. The information needed to characterize the stellar winds of massive stars is encoded in FUV spectra. Establishing the properties of these rotating outflows is a critical issue, since the present uncertainties restrict our understanding of the evolution of the angular momentum, the initial-to-final mass relation, and the ultimate fate of a massive star.

By fitting line profiles from sophisticated model atmospheres to the FUV spectra, we will measure photospheric CNO abundances, probe the rotation law of the stellar wind, and study the influence of rapid rotation on the profiles of wind lines, and hence on the determination of mass-loss rates. We will investigate how rapid rotation affects the onset of clumping, the presence of which reduces estimates of mass-loss rates. This program will enable decisive steps toward determining the nature of rapidly rotating, evolved, massive stars, as required to evaluate their suitability as progenitors of LGRBs.

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14684

Program Title: What is a Galaxy Halo Really Like?

Principal Investigator: David Bowen

PI Institution: Princeton University

In Cycle 20 we used COS to map the baryons in the halo of NGC 1097 by recording the absorption lines towards 4 QSOs whose sightlines passed through the galaxy's circumgalactic medium (CGM). In this proposal we seek to extend the map by observing 4 new probes within the virial radius of the galaxy, thereby improving the `resolution' of our map. NGC 1097 is a nearby, bright (cz=1271 km/s, L~ 1.7L*) spiral galaxy, which has the highest density of UV-bright background objects behind it. Our mapping consists of detecting Lyman-alpha (Lya) lines, as well as low-ionization lines of Si II and C II, and higher ionization lines of Si III and Si IV, from the galaxy's CGM. The analysis of our Cycle 20 data suggested that the CGM was dominated by rotating gas falling in from the IGM, with perhaps some smaller contribution from an outflow at small radii. With 4 new probes, we would test this conclusion more vigorously, and produce the most extensive map of the physical conditions of the baryons in a galactic halo outside of the Local Group.

Proposal Category: AR

Scientific Category: Galaxies

ID: 14553

Program Title: Grizli: The Grism redshift & Line Database for HST WFC3/IR Spectroscopy

Principal Investigator: Gabriel Brammer

PI Institution: Space Telescope Science Institute - ESA

The HST archive contains roughly 0.7 square degrees of coverage with the WFC3/IR grism elements, providing low spectral resolution / high spatial resolution slitless spectroscopy over the range 0.8--1.7 microns. The archive represents a heterogeneous mix of large, uniform programs and a variety of smaller programs focusing on more specifically selected targets such as galaxy overdensities and fields around distant quasars. Only the 3D-HST spectra---representing just 20% of the archival holdings in just the redder G141 grism---have been fully processed systematically and automatically. Here we propose the "Grizli" project to democratize access to WFC3/IR slitless spectroscopy and provide uniform processing, redshift and emission line measurements of the full WFC3 G102+G141 spectral archive. Novel benefits of the Grizli processing include 1) Increasing the areal coverage of catalogued redshift and line measurements by a factor of five, 2) Providing reduced spectra and simultaneous fits derived from both WFC3/IR grisms, and 3) Combining spectra in deep areas observed at multiple position angles. The uniform processing of the grism archive and rest-frame optical spectra for galaxies at $0.2 < z < 3.5$ will enable myriad scientific applications of the rich dataset. Among them we will focus on constraining the dust extinction towards HII regions in distant star-forming galaxies and determining robust emission line luminosity functions to help inform planning of future space-based cosmology missions such as WFIRST. All Legacy data products and the software tools used to generate them will be made freely available through the Hubble Legacy Archive.

Proposal Category: GO

Scientific Category: Solar System

ID: 14650

Program Title: A simple definative test for chloride salts on Europa

Principal Investigator: Michael Brown

PI Institution: California Institute of Technology

Europa is a prime location for exploring our concepts of habitability throughout the solar system. As importantly, Europa is a case study for how liquid water drives the geochemistry and geophysics in a world very different from our own. One of the keys to understanding the liquid water's effect on habitability, geochemistry, and even on geophysics is understanding the chemistry of the internal ocean. Evaporites on the surface of Europa provide a window into this ocean chemistry.

Recent observations have overturned 15 years worth of assumptions about the chemistry of Europa's ocean and have suggested that chloride salts -- rather than sulfate salts -- could be the most abundant constituent in the ocean and in the surface evaporites. The possibility of chloride salts has major implications for geophysics and habitability, but, because chloride salts are basically featureless, definitive spectral evidence was thought impossible.

New laboratory data now shows, however, that electron irradiation with Europa-like fluxes imparts distinct spectral absorption features on chloride salts. These spectral features, in specific bands between 430 and 830 nm, are uniquely accessible to high spatial resolution HST spectroscopy. We propose a very simple program to obtain four separate high spatial resolution STIS slit scans across the disk of Europa to construct a global spectral map which will detect and map these surface salts. These observations can definitively identify chloride salts on Europa and fundamentally change our understanding of this world. Rarely can such a simple and short program with HST have the possibility of obtaining such conclusive and transformative results.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14665

Program Title: Ultraviolet Spectra of a Normal Standard Candle

Principal Investigator: Peter Brown

PI Institution: Texas A & M University

Type Ia Supernovae (SNe Ia) are important tools in the study of our universe, but are not fully understood at rest-frame ultraviolet (UV) wavelengths. High quality spectra in the mid-UV (<2500 Angstroms) are scarce because of the need for space based observations and the faint flux levels in the UV due to the absorption of iron peak elements. While bad for flux levels, the iron line blanketing makes the UV spectrum very sensitive to differences in the temperature, density, and metallicity--important ingredients for SN modeling. An explosion of ultraviolet observations of type Ia Supernovae (SNe Ia) has revealed a diversity in the UV properties of even optically normal SNe. HST has recently obtained several excellent UV spectra reaching mid-UV wavelengths for examples of SNe that are "UV-blue" or have broad or moderately narrow optical light curves. Yet we are still lacking a good UV spectrum of an UV and optically normal SN Ia. Dozens of UV light curves from Swift/UVOT and dozens of rest-frame UV observations of high redshift SNe observed from the ground and HST will benefit from the physical insight gained from high quality UV spectra. These spectra will be crucial to modelling the varied behavior we observe in the UV. We propose target of opportunity observations with HST to provide mid-UV photometry and spectroscopy of a normal SN Ia this cycle. These will serve as benchmarks against which to compare photometry, other spectroscopy, and theoretical models.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14759

Program Title: What Happens in the Atmospheres of Hot Horizontal Branch Stars Near 20,000K?

Principal Investigator: Thomas Brown

PI Institution: Space Telescope Science Institute

In the color-magnitude diagrams (CMDs) of many globular clusters, the horizontal branch (HB) exhibits a long blue tail extending to high effective temperatures. In such clusters, two discontinuities appear within the HB locus. The first discontinuity occurs at ~12,000K, and was discovered by Grundahl et al. (1998). It is associated with the radiative levitation of metals and the gravitational settling of helium in the atmospheres of HB stars hotter than 12,000K. The hot subdwarf stars of the Galactic field population exhibit the same phenomenon. The second discontinuity occurs at ~20,000K, and was discovered by Momany et al. (2002). Its origin is unknown, but it appears at the same effective temperature in all globular clusters hosting HB stars near 20,000K, regardless of cluster properties (age, chemical composition, mass, etc.). We propose STIS long-slit spectroscopy of 6 HB stars that straddle this feature in the HB distribution of omega Cen, the nearest globular cluster where the feature is well populated. With this approach, we can efficiently obtain high-quality UV and blue spectra that span the full wavelength range of the photometric bands where this CMD feature is most prominent - a range this is only accessible by HST. The resulting spectra will unambiguously reveal the nature of this phenomenon - one that is universal in the atmospheres of hot evolved stars - and will yield new insight into the role of diffusion and radiative levitation in these stars.

Proposal Category: GO

Scientific Category: Solar System

ID: 14629

Program Title: Astrometry of 2014MU69 for New Horizons encounter

Principal Investigator: Marc Buie

PI Institution: Southwest Research Institute

We propose 12 orbits of time to make high-precision astrometric measurments of the New Horizons extended mission target, 2014MU69. These observations are in direct support of the navigation of New Horizons leading up to its encounter in Jan 2019. These visits represent an optimized plan for improved orbit estimates that will complete as the target becomes directly observable by New Horizons. This astrometry is a key element leading up to a close investigation of a Cold-Classical Kuiper Belt Object, one of the most primitive members of our solar system.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: IGM and COS

ID: 14554

Program Title: Accurate Predictions for Dark Matter Substructure

Principal Investigator: James Bullock

PI Institution: University of California - Irvine

Among the most fundamental predictions of LCDM cosmology is the existence of a large number of dark subhalos in and around galaxies, most of which should be entirely devoid of stars. Confirming the existence of this substructure stands among the most important empirical challenges in modern cosmology. The goal of this proposal is to make robust LCDM predictions for dark halo substructure using high-resolution cosmological simulations that explicitly include the effects of baryons via a fast hybrid N-body method as well as full hydrodynamical runs.

Observational studies of strong gravitational lensing systems using HST and other instruments have begun to detect substructures with masses approaching those where halos may be entirely dark. There is real hope that similar studies can detect and quantify subhalos with masses 100 times smaller. Moreover, the number of suitable lenses is expected to grow substantially in coming years. Stellar streams around the Milky Way provide an independent means of detecting substructure. The number of cold stellar streams is too expected to grow as surveys like LSST come on line.

While we are poised for phase-change in our ability to detect and quantify substructure, the current state of theoretical predictions is far behind. The vast majority of predictions include only dark matter and therefore neglect the destructive effect of central galaxies -- an effect that is know to reduce substructure significantly in the cores of halos, the very regions where observations are most sensitive. Our simulations will overcome this deficiency and provide the predictions needed to accurately interpret observational results.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 14760

Program Title: Imaging a Massive Galaxy Overdensity at z=2.3: The Morphology-Density Relation at High Redshift

Principal Investigator: Zheng Cai

PI Institution: University of California - Santa Cruz

We propose deep HST/WFC3 imaging in the density peak area of BOSS1441 protocluster at z = 2.32 traced by an extreme rare group of Ly-alpha absorbers and multiple quasars. This structure is selected from the large survey volume of 1 Gpc^3 covered by SDSS, and is the most overdense and robustly established cluster-sized overdensity at z ~ 2. This massive structure centered on a 7' x7' (12 Mpc x 12 Mpc) sub-region has the highest galaxy overdensity of 10.8+/-1.0, anchored by the largest and most luminous Lyman alpha nebula known at z>2. In this area, our Keck+ LBT observations have obtained the spectra for the unique Ly-alpha nebula, 20 strong Ly-alpha emitting galaxies at z=2.32+/-0.02, and 110 Lyman break galaxies (i < 24.5). This field is also covered in complete wavelength observations from U-band to K-band using ground-based imaging. Here we propose to use nine HST/WFC3 pointings to cover this central region in 9 orbits. We will measure the detailed rest-frame optical morphology of this sample, to determine whether the universal morphology-density relationship observed in the low-redshift universe is already in place in and around most overdense region at z ~ 2. We will also probe the powering mechanism of the largest Ly-alpha nebula, testing if this nebula is powered by merging of separated galaxies. Combining the new HST observations with the existing multi-wavelength imaging ranging from 0.3 - 2.3 microns, optical spectroscopy, and narrow-band imaging, we will provide a complete sample of galaxies in the most massive protocluster at z=2 which could be evolved into the most massive galaxy clusters (10^15 M_sun) in later epoch.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14666

Program Title: Astrometric Light Deflection Test of General Relativity for Non-spherical Bodies: Close Approach to Jupiter

Principal Investigator: Stefano Casertano

PI Institution: Space Telescope Science Institute

Einstein's theory of General Relativity is a key component of our understanding of cosmology, underlying the interpretation of cosmic acceleration in terms of Dark Energy. Gravitational lensing is a major element of modern observational cosmology, used both in reconstructing the mass distribution of galaxies and clusters of galaxies, and in predicting the magnification of sources behind massive clusters. An astrometric verification of gravitational lensing was historically the first experimental test of General Relativity, yet there has been to date no verification of the deflection predicted for a non-spherical source. We propose to use the astrometric capabilities of WFC3 in spatial scan mode to observe the apparent shift in position of several stars in three separate fields during their near-occultation by Jupiter. These measurements will provide two fundamental tests of General Relativity: (1) one of the most precise light-deflection tests ever conducted, and the most precise in the visible, verifying the GR prediction with a precision of 0.04%, and (2) the first measurement of the differential deflection due to the flattening of Jupiter's gravitational potential, verifying the GR prediction of deflection by a *non-spherical* mass with a precision of 5%.

Proposal Category: AR

Scientific Category: Stellar Populations

ID: 14555

Program Title: Identifying Globular Clusters Hosting Large Numbers of Black Holes

Principal Investigator: Sourav Chatterjee

PI Institution: Northwestern University

The detection by LIGO of gravitational waves emitted by merging black holes (BH) has generated widespread interest in the astrophysics of binary BH (BBH) formation. Discoveries of candidate BH X-ray binaries in Galactic and extragalactic globular clusters (GC) via X-ray and radio surveys indicate the possible existence of hundreds of BHs bound to GCs. Current theoretical models also suggest that GCs are efficient factories of BBHs. A large population of BHs can dramatically alter the global dynamical evolution of the host GC. Consequently, the observable GC properties, extensively studied and catalogued using HST, are also affected. We propose to create detailed numerical models of GCs to systematically study the effect of retained BHs on the 1) lifetime and survival of host GCs; 2) GC properties observable by HST; and 3) production and radial distibutions of tracers of dynamical interactions (e.g., blue stragglers, sub-subgiants, interacting binaries, and binary fraction). Our study will identify key observable GC properties that most reliably indicate the presence or absence of a large number of bound BHs. We will compare these properties with the wealth of GC data obtained by HST observations of GC cores to identify specific Galactic GCs that are most likely to host large populations of BHs at present. Our results will guide future observational searches for BH candidates in GCs in both the Milky Way and other galaxies. Moreover, these detailed models will provide unprecedented constraints on the number, radial distribution, binarity, dynamical and stellar evolution history for BHs in star clusters, thus connecting HST observations of GCs directly to LIGO astrophysics.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Galaxies

ID: 14556

Program Title: Cloudy as a Shock Modeling Code: Utility for HST, & Looking out to JWST

Principal Investigator: Marios Chatzikos

PI Institution: University of Kentucky

Shocks are a ubiquitous heating mechanism that produces non-equilibrium spectral emission. Its interpretation influences our understanding of a diverse set of astrophysical processes, such as supernova remnants (SNRs), molecular emission from external galaxies, AGN, and, most recently, the transition of starburst to red-and-dead galaxies.

In the most recent (from the mid-90s) code comparison project for steady shocks into ionized gas, the competing codes varied in their predictions for key observational signatures by factors of a few. Unfortunately, currently only two publicly-available shock-modeling codes exist: one for SNR-type shocks, and one for continuous shocks in molecular gas. Clearly, independent predictions for key observables are a much-needed asset for current and future observational programs in the optical and the infrared.

We request funding for a three (3) year Legacy Archival Theory program to upgrade Cloudy, a state-of-the-art microphysics code, to model shocks. This will double the number of publicly available shock codes, and will complement existing shock code predictions. The basis for achieving the goals of this program is already laid in Cloudy in its treatment of advective ionization fronts. In the first two years, we will focus on adapting the existing infrastructure to model shocks, and on faithfully representing the physics for each shock class. In the third year, we will focus on producing predictions for key observables for the benefit of the observing community.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14720

Program Title: Photometric Mapping of the Galactic Outflow in NGC 7552

Principal Investigator: Doron Chelouche

PI Institution: University of Haifa

Outflows are tightly linked to star-formation activity in galaxies with implications for star-formation regulation, metallicity gradients in disks, the enrichment of the intergalactic medium, and the missing baryons and satellites problems. However, the large uncertainties currently associated with the properties of galactic outflows preclude a more reliable investigation of the aforementioned topics. Here we propose a new technique for mapping the structure of these outflows using a combination of broad- and narrow-band UV photometry, which can reveal sub galactic-scale structures in the flow and correlations with the spatial structure of the underlying galaxy. The exploratory data that will be collected by this program for a particular target (NGC7552) - and, if proven successful, by future similar programs - will shed light on the typical length scales associated with outflows, their origin, acceleration means, and overall geometry. This in turn will help to better assess the mass loss rates and kinetic luminosities of galactic outflows, and provide crucial input for galaxy formation models.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14667

Program Title: Differentiating Gas Infall and Outflows with Resolved Star Formation Morphology

Principal Investigator: Hsiao-Wen Chen

PI Institution: University of Chicago

Traditional QSO absorption-line spectroscopy along single sightlines through galactic halos does not provide the necessary constraints for distinguishing between gas inflows and outflows, because of the degeneracy between line-of-sight velocity offsets from inflowing and outflowing gas. To break the degeneracy requires a sharper view of gas kinematics in galactic halos. We are initiating a program to spatially resolve halo gas motions using projected quasar pairs. The program has yielded a sample of 24 star-forming galaxies at redshift z=0.3-1.2 in five fields with resolved MgII absorption profiles available at two distinct locations separated by 30-60 kpc per galactic halo. A critical component in our study is spatially resolved morphologies of the star-forming disks which, when combined with absorption spectroscopy at multiple sightlines per galaxy, provide the necessary reference frame for constructing a 3D gas flow model. We propose to use ACS and the F814W filter to obtain high spatial resolution, optical images of the fields around the five projected QSO pairs in our sample. The primary goals are (1) to determine the morphological parameters of foreground galaxies identified in our survey and (2) to investigate possible connections between galaxy interactions/satellite mergers and metal transport to large galactic distances based on the presence/absence of disturbed morphologies/tidal features. With a minimal amount of HST time, we will be able to establish the first large sample of 24 intermediate-redshift galaxies for a comprehensive study of spatially and spectrally resolved interplay between star-forming disks and halo gas.

Proposal Category: GO

Scientific Category: Solar System

ID: 14752

Program Title: Variability in the Escape of Water from Mars

Principal Investigator: John Clarke

PI Institution: Boston University

The present-day escape of water from the atmosphere of Mars must be understood to extrapolate back in time to determine past conditions on the red planet. To be able to perform this extrapolation accurately, we need to determine the factors that control the escape of H and O today. This work is well underway with observations of the martian exosphere by HST and MAVEN. We have established that the H escape rate is highly variable over the course of a martian year (factor of ten), with strong seasonal variations in the exospheric H density, but the controlling factor(s) are not yet well determined. This proposal is to extend this work with HST observations in Fall 2016 during martian southern summer, when both the H escape flux and the dust storm activity are at maximum levels. This period corresponds to a time when the MAVEN IUVS will not be able to measure exospheric H due to its orbital geometry, and it corresponds to the arrival of ExoMars in a high altitude capture orbit where this mission will have a good global view of Mars. The coordinated observations with HST, MAVEN, and ExoMars will allow us to measure short term changes in the lower and upper atmospheres during a key time of the Mars seasons, when the escape flux is highest, Mars is closest to the Sun, and there is the highest level of dust storm activity. We will use the relative timing of atmospheric changes to determine cause and effect leading to the large changes in the escape of water. This proposal supports the HST UV initiative.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14761

Program Title: Mapping the UV Extinction Properties of PHAT Stars in M31

Principal Investigator: Geoffrey Clayton

PI Institution: Louisiana State University and A & M College

We propose to construct high-quality UV extinction curves for interstellar dust in M31 by obtaining new low resolution STIS spectra in the G140L and G230L gratings of 15 reddened OB stars in M31 chosen from a newly available list of spectral types. We are choosing sightlines that lie in the footprint of the Panchromatic Hubble Andromeda Treasury (PHAT) survey. Focusing our study on the detailed properties of M31 dust grains via UV spectroscopy with HST/STIS will mean that we can directly connect the variations seen in the UV extinction curves with their environment. By selecting our M31 sightlines in the PHAT survey region, we will be able to probe a variety of potential correlations between dust grains and their environment. These new M31 UV extinction curves along with the gas-to-dust ratio inferred from the Ly-alpha HI column, existing M31 abundance measurements, and the information from the PHAT survey will be inputs to our Maximum Entropy Method (MEM) models to analyze the dust grain populations. In particular, the PHAT survey provides spatially resolved data on the stellar and interstellar environments near to the sightlines being studied as part of this program. We will investigate whether solar (Milky Way) and super-solar (M31) metallicity galaxies have significant variations in their UV extinction properties. This proposal is part of a long-term program to investigate the extinction properties of interstellar dust across a sample of galaxies with different global characteristics such as metallicity and star formation activity.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14630

Program Title: A unique probe of the dark matter distribution in a halo at z=1: A strong lens with a bright central image

Principal Investigator: Thomas Collett

PI Institution: University of Portsmouth

Cosmological dark matter simulations predict that the central regions of halos have 1/r density cusps. Baryonic processes and dark matter microphysics may resculpt these dark matter cusps, but these process are poorly understood and only weakly constrained by observations of a few low redshift halos.

We have discovered a strong lensing cluster at redshift 1 that includes a bright central image like no other: the central image is resolved! This makes for a uniquely powerful probe of the central regions of a dark matter halo without the need for additional dynamical constraints. An NFW halo cannot reconstruct the data: modelling of our DECam imaging with a double powerlaw density profile shows that the central slope must be much shallower than 1/r over at least the central 35 kpc.

We propose to obtain high resolution imaging of this lens with WFC3. This data will be able to conclusively distinguish between a large core and an even larger shallow cusp. It will be the first such measurement at z = 1 and the most precise measurement of the central DM profile of a cluster ever made. The data will also allow for an investigation of dark matter substructures at z=1. When combined with cosmological hydrodynamical simulations these results will place new constraints on the range of baryonic processes and DM microphysics that can flatten the central density profiles of cluster DM halos over kiloparsec scales.

Proposal Category: AR

Scientific Category: Galaxies

ID: 14557

Program Title: Measuring the Star Formation History of the Local Universe

Principal Investigator: Charlie Conroy

PI Institution: Harvard University

The main body of nearly every galaxy within 20 Mpc is in the `semi-resolved' regime, in which source confusion/crowding dominates, and yet the brightest stars (e.g., massive stars and evolved giants) are rare enough to induce stochastic fluctuations in the light distribution. In this regime we define the concept of pixel color magnitude diagrams (pixel CMDs), which allow one to reconstruct non-parametric star formation histories (SFHs) from semi-resolved imaging data. Here we propose to analyze pixel CMDs for 20 galaxies within 20 Mpc in order to measure spatially resolved SFHs for a representative sample (by mass) of galaxies within the local universe. These measurements will enable a first estimate of the total SFH within the local volume, which can then be compared to the cosmic SFH from lookback studies and to detailed galaxy formation models. The resulting SFHs will also be used to investigate variations across morphological types, radial variations within galaxies, and differences (or not) between ellipticals, classical, and pseudobulges. As part of this program we will deliver a suite of well-tested tools for analyzing pixel CMDs from HST data.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14704

Program Title: A Year in the Whirlpool

Principal Investigator: Charlie Conroy

PI Institution: Harvard University

The goal of this proposal is to derive the spatially-resolved star formation history (SFH) of the Whirlpool Galaxy (M51), a nearby face-on grand design spiral. Ages will be estimated from the periods and luminosities of long period variable stars (LPVs), which are very luminous, cool evolved stars. We propose to measure these periods and luminosities by monitoring M51 over 365 d with 34 discrete visits. Simulated observations including the effects of variable stars imply that 50% of pixels will show >2% flux variation over the 365 d baseline. The derived SFH map will be used to address a number of key questions including the morphology and mass of the ancient stellar component, the radial extent of the galaxy as a function of age, the SFH within, along, and in between the spiral arms, and the SFH of the central mass concentration. The visits will be randomly spaced in time in order to maintain sensitivity to a wide range of variable star periods and transients besides LPVs (including Cepheids, LBVs, and novae). Coordinated parallel observations will provide images outside of M51's disk, enabling the characterization of the stellar population of its halo.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 14721

Program Title: The Fundamental Plane of Ultra-Massive Galaxies at z~2

Principal Investigator: Christopher Conselice

PI Institution: University of Nottingham

The fundamental plane (FP), relating the effective radius, velocity dispersion, and surface brightness is a unique tool for studying the structural, stellar, and dark matter evolution of early-type galaxies, and can reveal how these galaxies have formed and evolved. Thus far, studies have been mostly limited to z<1.3, beyond which the absorption lines used to derive velocity dispersions are redshifted out of the optical. With the advent of sensitive NIR spectrographs on 8m telescopes, it is now possible for the first time to study the FP directly at the epoch (z~2), where lower redshift studies predict it to have formed. Through a large investment of time with the 8m - VLT NIR spectrograph X-SHOOTER, we have derived velocity dispersions for a unique sample of 11 quiescent galaxies at z=2, tripling the number of galaxies with such measurements. We propose to obtain WFC3/IR imaging of these galaxies, which when combined with our ground-based spectroscopy, will allow us to measure accurately the fundamental plane at z~2 for the first time through accurate sizes derived from surface brightness profile fits to the data. This measurement of the FP will further reveal the time-scales and methods of formation for the most massive early type galaxies. The HST observations will also allow us to measure the structures of these galaxies, to search for any extended envelopes or asymmetries, and to examine the properties of their satellite galaxies. Three of our systems also show hints of having close companions through our spectroscopy and WFC3/IR imaging is required to investigate this further.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14705

Program Title: Confirming interstellar C60+ using a new method for high signal-to-noise NIR STIS spectroscopy

Principal Investigator: Martin Cordiner

PI Institution: Catholic University of America

Due to recent advances in laboratory spectroscopy, the first detection of a large molecule has been claimed in the diffuse interstellar medium: C60+ (ionized Buckminsterfullerene). If confirmed, the detection of C60+ will constitute a major breakthrough in interstellar chemistry and may provide, for the first time, an insight into the true chemical complexity of the diffuse ISM. Confirming the presence of C60+ rests on a rigorous detection of the weaker absorption lines of this molecule at 9365 and 9428 Angstroems - a region of the spectrum heavily obscured in ground based studies due to telluric water vapour absorption. We seek to demonstrate for the first time the feasibility of long-slit STIS scan exposures to reach an unprecedented signal-to-noise ratio >500 in the near-IR. These observations will eliminate the need for error-prone telluric cancellation methods, allowing us to search for and measure the weak C60+ features with sufficient accuracy to confirm or reject the recently claimed C60+ discovery. If successful, our CCD fringing reduction strategy would be a major breakthrough for precise spectroscopic observations of various astrophysical phenomena in this previously less well-explored wavelength region.

Proposal Category: GO

Scientific Category: Solar System

ID: 14795

Program Title: Observing an artificial meteor: Cassini's entry into the atmosphere of Saturn

Principal Investigator: Frank Crary

PI Institution: University of Colorado at Boulder

The Cassini spacecraft's mission at Saturn will end after over 13 years in orbit, on September 15th, 2017. The spacecraft will be disposed of by impacting Saturn and its atmospheric entry will be that of an artificial meteor. The resulting bolide will be observable in the far ultraviolet using Hubble Space Telescope's STIS instrument. We propose to observe this event using STIS-FUV MAMA, in TIME-TAG imaging mode. The goal of this observation is to determine the luminous efficiency of hypervelocity impacts on gas giants. Recent observations of meteor flashes on Jupiter could be used to determine the flux and size distribution of meteors in the outer solar system, but only if the luminoius efficiency is known. With a well-known mass (2186 kg) and impact velocity (34.9 km/s), the Cassini impact will provide this information. An additional goal is the validate and improve the existing model of Saturn's atmosphere, between 1 nanobar and a few microbars. This region is of particular interest to the interpretation of aurora observations and to the development of future missions involving atmospheric probes.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14796

Program Title: An extremely asymmetric dwarf satellite distribution around M101

Principal Investigator: Denija Crnojevic

PI Institution: Texas Tech University

We request HST/ACS imaging to follow up 19 new faint candidate dwarfs around the "peculiar" Milky Way analog M101 (at ~7 Mpc). Motivated by the recent discovery of seven diffuse candidate satellites of M101 (Merritt et al. 2014) which show a strongly asymmetric spatial distribution, we performed a systematic search of archival ground-based data (CFHT/Megacam) within a ~180 kpc radius around M101. Our candidate satellites extend M101's satellite luminosity function by two orders of magnitude (down to M_V~-7), but most intriguingly they confirm the spatial distribution observed in previous studies. While this is suggestive of a group of dwarfs possibly infalling onto M101, the extreme nature of the satellite distribution asymmetry around a MW analog constitutes the real mystery of this result. The observed slope of the satellite luminosity function below M_V~-14 in nearby spiral-dominated groups is at odds with Cold Dark Matter predictions: the inclusion of small-scale physics in simulations helps alleviate this tension and a substantial halo-to-halo scatter is expected, but the absence of an "intrinsic" satellite population around M101 makes this an extreme, and extremely interesting, case study. Any conclusion on the nature of M101's satellites is, however, put on hold until we can confirm their group membership. Only HST will allow us to resolve these candidate satellites into stars and obtain accurate (~20%) distances with the tip of the red giant branch method as well as robust luminosities, which are key to meaningfully interpret the true nature of this group of dwarfs.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14722

Program Title: A Local Laboratory for Studying Positive Feedback from Supermassive Black Holes

Principal Investigator: Steve Croft

PI Institution: Eureka Scientific Inc.

AGN feedback is a critical regulator of galaxy growth. As well as curtailing star formation in diffuse, hot gas, it is increasingly understood to sometimes enhance star formation in the clumpy ISM through shock-induced collapse of clouds. Simulations have shown that such positive feedback may play a significant role in determining the stellar populations of galaxies. Minkowsi's Object (MO) provides an excellent local laboratory to probe this poorly-studied process in detail. The detection of a Type II supernova in MO (unexpected given the low mass of MO) suggests that jet-induced star formation may overproduce massive stars, and that models of the initial mass function in such systems may need to be revised. Recent results also suggest that star formation efficiency is enhanced in MO.

Using WFC3, we will obtain morphologies, SEDs, H-a luminosities, equivalent widths, sizes, and population synthesis models of star forming regions across MO in order to address these questions, critical for understanding not just this single object, but the general process:

1. Does jet induced star formation change the luminosities and initial mass functions of star clusters?
2. What do the age gradients of the star clusters tell us about the process of conversion of gas (HI, CO) into stars as the radio jet progressed through the parent cloud? Does this match numerical simulations?
3. By using observations to refine simulations, what can we learn about intrinsic properties of these kinds of radio jets, such as propagation speed, age, pressure and jet energy flux?

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14797

Program Title: Atmospheric Albedos, Alkalis, and Aerosols of Hot Jupiters

Principal Investigator: Ian Crossfield

PI Institution: University of Arizona

The lack of visible-wavelength albedo measurements for even the best-characterized hot Jupiters is a gaping hole in our current understanding of these planets' atmospheres, as the UV+optical albedo spectrum contains a wealth of information about the atmosphere that is unavailable at other wavelengths. Rayleigh scattering and absorption by atoms, molecules, and cloud condensates all sculpt the as-yet unexplored visible reflection and emission spectra of hot Jupiters -- but the relative contributions of these processes remains undetermined.

We propose to measure the UV+optical reflection spectra of the four best-studied hot Jupiters with STIS, building on our one-eclipse STIS pilot program that measured the first low-S/N exoplanetary albedo spectrum. Our proposal will greatly expand on our previous measurement by bringing higher spectral resolution, higher S/N, and a larger sample of well-studied planets. With these data, our full program will: (1) test for highly reflective mineral clouds on these planets' day sides; (2) measure the abundances of alkalis and any atmospheric aerosols; (3) measure the composition and size distributions of cloud or haze particles; and (4) explain the discrepancy between these planets' Bond and geometric albedos.

HST/STIS is the only current or planned instrument that can make these observations. This program leverages HST's unique UV+optical sensitivity shortward of 600 nm, in preparation for the JWST GTO/Cycle 1 spectroscopy at longer wavelengths that will complement our observations of these touchstone planets.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations
ID:	14595
Program Title:	Correlating proper motion kinematics with stellar properties in a very young protocluster
Principal Investigator:	Nicola Da Rio
PI Institution:	University of Florida

We recently obtained the first epoch of a multi-cycle HST program (GO13742) aimed at the study of massive star cluster formation through proper motion-based analysis of kinematics. This program targeted the young, gas-dominated, still-forming protocluster G286 with WFC3/IR J, H and narrow band F167N, reaching down to the H-burning limit at A_V=20, and well into the substellar regime for the less-embedded parts of the system. With the second epoch (cycle 24) we will derive proper motions, kinematic subclustering, runaway objects and determine the overall expansion/contraction of the system.

Here we propose to complement these observations with additional photometric bands, which will allow us to derive the stellar parameters of the low-mass members. We plan to use the H2O Teff band at 1.4micron, with a continuum at 1.3micron, to disentangle Teff and A_V for all low-mass young stars down to the H-burning limit at A_V=20, matching our previous data. This will enable us to construct the HRD, assign ages, look for spatial age gradients, and compare kinematic properties with age. Specifically, the identification of systematic variations in the proper motions with age will enable us to trace the initial morphology of the system at its formation, and determine the kinematic association of older stars with younger. Last, we plan to obtain accurate fluxes in Paschen beta, whose excess is indicative of accretion (allowing us to measure Mdot) and is an independent indicator of membership.

Accretion properties, with ages, masses, and dynamics will enable a comprehensive picture of this young, massive protocluster in formation, testing theories of massive star cluster formation.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: IGM and COS

ID: 14558

Program Title: Probing dark matter physics with galaxy clusters

Principal Investigator: Neal Dalal

PI Institution: University of Illinois at Urbana - Champaign

We propose a theoretical investigation of the effects of a class of dark matter (DM) self-interactions on the properties of galaxy clusters and their host dark matter halos. Recent work using HST has claimed the detection of a particular form of DM self-interaction, which can lead to observable displacements between satellite galaxies within clusters and the DM subhalos hosting them. This form of self-interaction is highly anisotropic, favoring forward scattering with low momentum transfer, unlike isotropically scattering self-interacting dark matter (SIDM) models. This class of models has not been simulated numerically, clouding the interpretation of the claimed offsets between galaxies and lensing peaks observed by HST. We propose to perform high resolution simulations of cosmological structure formation for this class of SIDM model, focusing on three observables accessible to existing HST observations of clusters. First, we will quantify the extent to which offsets between baryons and DM can arise in these models, as a function of the cross section. Secondly, we will also quantify the effects of this type of DM self-interaction on halo concentrations, to determine the range of cross-sections allowed by existing stringent constraints from HST. Finally we will compute the so-called splashback feature in clusters, specifically focusing on whether SIDM can resolve the current discrepancy between observed values of splashback radii in clusters compared to theoretical predictions for CDM. The proposed investigations will add value to all existing deep HST observations of galaxy clusters by allowing them to probe dark matter physics in three independent ways.

Proposal Category: GO

Scientific Category: Stellar Pops

ID: 14610

Program Title: A Legacy Imaging Survey of M33

Principal Investigator: Julianne Dalcanton

PI Institution: University of Washington

We propose a panoramic imaging survey of M33 to extend the M31 PHAT survey to regions with 10x higher star formation intensity and markedly lower metallicity. Deep six-filter UV/optical/IR stellar photometry will provide (1) precision measurement of the high-mass IMF slope; (2) spatially-resolved maps of the recent star formation history (SFH) with ~5-10 Myr resolution; (3) maps of the cool, dusty ISM with 25 pc resolution; (4) temperatures and luminosities for ~15 million stars; (5) maps of extinction law variations; and (6) ~1000 star clusters with well-measured ages and masses. We will combine these products with archival multi-wavelength data to elucidate the astrophysics of the interstellar medium (ISM). We will constrain the energetics of the ISM by linking the history of stellar energy input to the observed properties of the ISM; reconcile widely-used, but discrepant, dust emission models; disentangle the drivers that control dust composition; and measure lifetimes of molecular clouds. We will survey nearly all the molecular clouds and high extinction (A_V>1) regions in M33, as well as regimes of star formation rate intensity, spiral arm strength, metallicity, and ISM pressure that are distinct from those in comparable surveys of M31 and the Magellanic Clouds. This survey adds M33 to the Milky Way, M31, and Magellanic Clouds as the fundamental calibrators of ISM physics, star-formation processes, and stellar evolution. The resulting data set will be comprehensive, highly versatile, and have tremendous legacy value. This program can only be accomplished with HST.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14723

Program Title: What controls the onset of the multiple population phenomenon within globular clusters?

Principal Investigator: Emanuele Dalessandro

PI Institution: Universita di Bologna

The origin of the multiple populations (MPs) seen in nearly all globular clusters (GCs) is still unknown, with all suggested scenarios having serious shortcomings. While large ground based spectroscopic samples and space based imaging surveys have provided a wealth of data and shown how complex the situation is, they have not been able to pinpoint the GC property that controls whether MPs are present. GC mass is traditionally the assumed dominant factor, but recent results suggest a more complex scenario where the mass cannot be the only parameter.

Hence, in order to make progress we need to understand which objects (if any) do not host MPs, and ultimately which property is responsible for the onset of MPs. Here we target two GCs that have been suggested to not host MPs (based on ground based imaging or abundance analyses of small stellar samples), Ruprecht 106 and IC 4499. These two clusters are "typical" in terms of age and mass of GCs, which would make the lack of MPs all the more surprising, if confirmed. If so, more exotic properties may have played a role (i.e., the type of galaxy where the clusters formed).

Proposal Category: GO

Scientific Category: Blackholes

ID: 14631

Program Title: Resolving the Nuclear Structure of the Canonical Radio Galaxy M87

Principal Investigator: Charles Danforth

PI Institution: University of Colorado at Boulder

The nearby galaxy M87 is the prototype for low-power radio-loud FR1-type AGN, the parent population of BL Lac type blazars. Despite its proximity, brightness, and nearly a century of observations, the physical picture of how the AGN emission is fueled and what is causing the bright and variable emission in the core of M87 is still mysterious. Recent COS observations show a complex and variable line profile and weak UV continuum with hints of spatial structure (Danforth et al. 2016). Consistent with recent X-ray observations, we find little accreting gas inside the Bondi radius. We propose to resolve and precisely locate the ionizing continuum and Ly alpha line-emitting structures with long-slit far-UV STIS spectra of the nucleus. These observations will also allow us to confirm (or not) the density-bounded nature of the line emission. Along with the spatially-resolved spectroscopy, we will use multi-epoch, high-S/N COS aperture spectroscopy to address the mystery of what powers this common yet poorly-understood class of active galaxies.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14651

Program Title: Recurrent Nova M31N 2008-12a: The surrounding 'Super-Remnant' - A signpost to Type Ia Supernova progenitors

Principal Investigator: Matthew Darnley

PI Institution: Liverpool John Moores University

M31N 2008-12a is the single most important nova system in the Andromeda Galaxy. With an unprecedented eight observed eruptions in just eight years, an ultra-high mass white dwarf, a high mass accretion rate, and low ejected mass, this system is now the leading pre-explosion Supernova Type Ia progenitor candidate in any galaxy. We have recently uncovered a vast elliptical nebula, centered on the erupting nova - a probable recurrent nova 'super-remnant', a relic of many thousands of past eruptions. State-of-the-art 'multi-cycle' nova eruptions models have shown that a C-O WD in a short-recurrence period nova does indeed grow towards the Chandrasekhar mass. Such models predict frequent 'He-flashes', ejecting significantly more mass at higher velocities, every 100 or so nova eruptions. We propose to utilize the unique high-spatial resolution capabilities of HST at visible wavelengths to obtain a series of deep H-alpha images to: (i) confirm the origin of the nebula; (ii) search for the signature - ripples - laid down in the super-remnant by the frequent He-flashes, hence (iii) constrain models of the remnant, allowing extrapolation to other systems, and (iv) validate long-term nova eruption models, and also (v) explore shaping mechanisms both by the nova process and surrounding ISM. Confirming this super-remnant's source as multiple recurrent nova eruptions would provide a fascinating, unexpected, but crucial signpost around Type Ia Supernovae - pointing directly to the progenitor pathway.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: IGM and COS

ID: 14559

Program Title: Raiders of the Lost Arcs

Principal Investigator: William Dawson

PI Institution: Lawrence Livermore National Laboratory

Gravitational lensing by massive galaxy clusters has enabled more efficient searches for high-redshift galaxies, including discoveries out to z ~ 11. Lensing has also revealed the intrinsically faintest galaxies yet known, extending luminosity function constraints several magnitudes fainter than the UDF. These faint galaxy constraints are crucial to understanding early galaxy evolution and reionization. However, current galaxy detection methods fall short of detecting the intrinsically faintest galaxies. Highly magnified galaxies are usually strongly sheared (elongated) and often blended with cluster galaxies as well. We recently showed that these two effects can lead to losses of more than half of the lensed sources in the high magnification regime, especially for the highest redshift galaxies. We have developed a promising method that can recover these lost arcs, primarily via a forward modeling approach that uses the cluster lens model to develop a spatially varying multi-epoch optimal filter to detect the faint arcs. Further testing is required to quantify our recovery rates and test the resulting photometry in surveys such as CLASH, the Frontier Fields, and RELICS. In doing so, we will realize the true power of these cosmic telescopes enabling us and others to maximize the investment of HST in these cluster surveys by finding the highest redshift sources, improving constraints on z > 8 luminosity functions, and better understanding the epoch of reionization. Additionally, this HST investment will see further returns as these lost arcs will make the ideal targets for extended follow-up with JWST and extremely large telescopes.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14724

Program Title: Searching for a radio millisecond pulsar in a low-mass X-ray binary

Principal Investigator: Nathalie Degenaar

PI Institution: University of Cambridge

Low-mass X-ray binaries (LMXBs) and millisecond radio pulsars (MSRPs) are two different manifestations of neutron stars in binary systems. Their evolution paths are thought to be linked, but many questions about their connection remain. Recently, three neutron stars have been discovered to transition back and forth between LMXB and MSRP states, opening a new vista to investigate the link between these different manifestations. The neutron star LMXB SAX J1808.4-3658 is a strong candidate to belong to this new class of transitional objects. Here, we propose to exploit the unique UV capabilities of the HST to search for the presence of an accretion disk in the quiescent state of this system. This gives insight into whether it can turn on as a MSRP when not accreting and hence if it is indeed a transitional object. In addition, we will search for thermal emission from the surface of the unusually cold neutron star in SAX J1808.4-3658, which has important implications for the physics of ultra-dense matter.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14725

Program Title: Hunting for Brown Dwarfs in Globular Clusters: Second Epoch Deep IR observations of the Globular Clusters M4

Principal Investigator: Andrea Dieball

PI Institution: Universitat Bonn, Argelander Institute for Astronomy

We propose to obtain a second epoch of deep WFC3/F110W imaging of the globular cluster M4 to confirm (or rule out) the first brown dwarfs (BDs) detected in this cluster. In a first epoch of deep WFC3 IR imaging of M4, four good BD candidates were identified. We will use a second epoch to test whether the BD candidates share the proper motion of the cluster population or not, thereby confirming (or ruling out) these sources as genuine cluster members. Confirming these sources as cluster BDs is crucial if we want to fill the observational plane with old and metal-poor benchmark sources that are much needed if we are to test and calibrate models about BD atmospheres, BD formation and evolution.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14726

Program Title: Ruprecht 106: Too small to succeed?

Principal Investigator: Aaron Dotter

PI Institution: Harvard University

Photometric studies with HST have completely changed our understanding of globular clusters (GCs), to the point where features that were once considered anomalous (light-element abundance variations, multiple populations) are now part of the definition of the term 'globular cluster'.

With this proposal, we seek to establish some minimum requirements for the formation of multiple stellar populations in GCs. We will apply the unique UV and blue imaging capabilities of the Wide Field Camera 3 UVIS channel to search for multiple stellar sequences, or lack thereof, in the CMD of the peculiar GC Ruprecht 106. Ruprecht 106 is exceptional among the Galactic GC population in its primordial chemical composition, low mass, and (likely) extra-Galactic origin. The limited abundance information available from spectroscopy indicates a low oxygen abudance (average [O/Fe] ~ 0 at [Fe/H] ~ -1.5) with no significant star-to-star scatter in the light elements.

Light element abundance variations are one of the fundamental signatures of multiple stellar populations in GCs; the other is the presence of multiple stellar sequences in the CMD. The first line of inquiry, spectroscopy, suggests Ruprecht 106 may be a true simple stellar population. This proposal addresses the second line of inquiry, the photometric signature, which has never before been attempted. The unrivaled resolution and sensitivity of the Hubble Space Telescope will allow us to discover whether the CMD of Ruprecht 106 reveals multiple and/or broadened stellar sequences and, thus, hosts multiple stellar populations -- or not.

Proposal Category: GO

Scientific Category: Solar System

ID: 14798

Program Title: Origin and Evolution of the First Known Ultra-Young Asteroid Family and its Doubly-Synchronous Binary Member

Principal Investigator: Michal Drahus

PI Institution: Uniwersytet Jagiellonski

Our GO-14192 and DD-14475 programs executed in late 2015 and early 2016, providing spectacular WFC3/UVIS images of the unusual disrupted asteroid P/2012 F5. We have detected at least nine star-like fragments of the main nucleus, still cocooned in their birth dust trail, suggesting that P/2012 F5 is a newborn asteroid family, only a few years old. Given that the main nucleus rotates at a critical rate, this ultra-young system is the best candidate for a family generated by rotational fission, as opposed to all the other asteroid families, which are of collisional origin. To our great surprise, the largest fragment of the main nucleus is most probably a small, doubly-synchronous binary, challenging the established theory of formation of binary asteroids. Capitalizing on these exciting early results, we propose a long-term monitoring program of P/2012 F5, with which we wish to secure new data from the next two oppositions. The requested additional HST orbits are critically needed to quantify the ejection parameters of the fragments and thereby verify the suspected cause of the fragmentation. They will also provide absolutely unique insight into the evolution of the first known ultra-young asteroid binary. Hubble is the only facility with sufficient sensitivity and wide-field angular resolution to carry out this investigation, which is more than likely to have a profound impact on asteroid science, including our solar system and systems around other stars.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14727

Program Title: Probing Super Star Cluster formation in the most favorable environments: the metal-enriched, gas-rich and turbulent collisional ring of NGC 5291

Principal Investigator: Pierre-Alain Duc

PI Institution: Commissariat a l'Energie Atomique (CEA)

The formation of massive super star clusters (SSCs), and possibly Globular Clusters, is predicted to be enhanced in a medium characterized by a high gas density, turbulence and moderate metallicity. These are precisely the conditions observed at high redshift in the distant star-forming galaxies, and locally by our proposed target: the huge collisional gaseous ring surrounding the early type galaxy NGC 5291. This massive HI structure expanded into the intergalactic medium after a high speed collision. It formed a series of gravitationally bound dwarf galaxies, where numerous massive SSCs are expected to be found.

We will (i) identify SSCs based on multi-band WFC3 images, (ii) derive their mass function, and (iii) compare their properties with environments that should be less favourable for the formation of massive SSCs, such as the metal-poor Blue Compact Dwarf Galaxies and the central tidally-affected regions of major mergers.

The ring around NGC 5291, and the condensations therein, for which a tremendous dataset is already available, are arguably the best local analogues of distant galaxies, since both have a very high gas fraction of 50%, a high turbulence of a few tens of km/s, a clumpy morphology, and a metallicity of half solar. The proposed observations will thus provide strong constraints on the ability of distant galaxies to form massive SSCs which might be the progenitors of today's globular clusters.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: IGM and COS

ID: 14560

Program Title: Diagnosing the Multiphase Circumgalactic Medium

Principal Investigator: Nicholas Earl

PI Institution: Space Telescope Science Institute

The characterization of the multiphase circumgalactic medium (CGM) around low-redshift galaxies has been a key development enabled by COS. Yet we still have a poor understanding of the spatial relationships between the various phases of the CGM, which limits our grasp of the mechanisms by which gas is expelled from and accretes (back) onto galaxies. To address this fundamental limitation, we propose an archival program to develop new, more robust, tools for extracting the information encoded in the kinematic profiles of low-ion and high-ion absorption in the COS CGM dataset. These profiles contain a wealth of information on the dynamics and sub-structure of the CGM, yet their vast potential remains untapped. We propose to apply our unique approach of statistically comparing absorption line profiles in the vast COS/FUV data contained in the newly-released Hubble Spectroscopic Legacy Archive (HSLA). With our complementary MISTY project, which generates synthetic spectra from hydrodynamic simulations, we will for the first time be able to apply our technique to carefully-simulated data. This joint approach will provide a deeper understanding of the basic structure of the CGM and its role in the baryon cycle.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14799

Program Title: Why the Different Looks of Changing-Look Quasars?

Principal Investigator: Michael Eracleous

PI Institution: The Pennsylvania State University

We propose to take UV spectra of three representative changing-look quasars that we recently discovered. The parent sample of 12 changing-look quasars comprises the first luminous examples of a newly-appreciated phenomenon and represents the tip of the iceberg. Their defining characteristic is a sharp decline in the broad emission lines and non-stellar continuum by an order of magnitude or more over a time-scale of a decade or less. They may represent the obscuration of the central engine or an abrupt dimming of the accretion-powered light of the quasar. We thus aim to definitively discriminate between these two possibilities with a straightforward UV spectroscopic test. Determining the cause of the "off" state can point to thermal or other instabilities in the black hole accretion flow and will also have implications for the ionization structure that quasars impart on the intergalactic medium. We also wish to exploit this unique opportunity to isolate the narrow UV emission lines, use their response to the decaying continuum to probe the structure of the interface between the broad- and narrow-line region, and find how their profiles introduce uncertainties in empirical schemes for determining black home masses.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14632

Program Title: Lyman-alpha Imaging at ~20 pc Resolution in a Low Mass Lensed Galaxy at z=1.85

Principal Investigator: Dawn Erb

PI Institution: University of Wisconsin - Milwaukee

Because Lyman-alpha photons are resonantly scattered by neutral hydrogen, the strength and spatial extent of Lya emission in galaxies depend on the HI column density and covering fraction, properties that are of primary interest to the escape of ionizing radiation. Lya emission is particularly important to the study of low mass, low metallicity galaxies: such objects are likely to be responsible for the reionization of the universe, and Lya emission is more common in these galaxies. With this proposal, we request 7 orbits of WFC3/UVIS imaging to obtain a high resolution map of Lya emission in the low mass, low metallicity z=1.85 gravitationally lensed galaxy SL2SJ021737-051329. With oxygen abundance <10% of solar, stellar mass <10^8 Msun, and extremely strong Lya emission with rest-frame equivalent width ~120 A, this object is a prime example of a low mass Lya-emitter, and its gravitational magnification by a factor of ~35 results in remarkably high WFC3/UVIS spatial resolution of ~20 pc. Existing HST broadband and IR grism observations will allow us to compare the spatial extent of the Lya emission with both the rest-frame UV continuum and the rest-frame optical nebular line emission, in order to map the resonant scattering of Lya photons from their origin in star-forming regions, obtain constraints on the location of the scattering gas, and relate this information to the kinematics and geometry of the galaxy. The proposed observations, in combination with the spectroscopic information we have already obtained, will provide the most comprehensive and highest resolution picture of Lya emission at z > 1 to date.

Proposal Category: AR

Scientific Category: Stellar Physics

ID: 14561

Program Title: Kernel-Phase Interferometry for Super-Resolution Detection of Faint Companions

Principal Investigator: Samuel Factor

PI Institution: University of Texas at Austin

Direct detection of close in companions (binary systems or exoplanets) is notoriously difficult. While chronagraphs and point spread function (PSF) subtraction can be used to reduce contrast and dig out signals of companions under the PSF, there are still significant limitations in separation and contrast. While non-redundant aperture masking (NRM) interferometry can be used to detect companions well inside the PSF of a diffraction limited image, the mask discards ~95% of the light gathered by the telescope and thus the technique is severely flux limited. Kernel-phase analysis applies interferometric techniques similar to NRM though utilizing the full aperture. Instead of closure-phases, kernel-phases are constructed from a grid of points on the full aperture, simulating a redundant interferometer. I propose to develop my own faint companion detection pipeline which utilizes an MCMC analysis of kernel-phases. I will search for new companions in archival images from NIC1 and ACS/HRC in order to constrain binary and planet formation models at separations inaccessible to previous techniques. Using this method, it is possible to detect a companion well within the classical l/D Rayleigh diffraction limit using a fraction of the telescope time as NRM. This technique can easily be applied to archival data as no mask is needed and will thus make the detection of close in companions cheap and simple as no additional observations are needed. Since the James Webb Space Telescope (JWST) will be able to perform NRM observations, further development and characterization of kernel-phase analysis will allow efficient use of highly competitive JWST telescope time.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Blackholes

ID: 14596

Program Title: Is Lyman Alpha Emitter CR7 Powered by a Direct Collapse Black Hole?

Principal Investigator: Xiaohui Fan

PI Institution: University of Arizona

Discoveries of luminous quasars powered by supermassive black holes (BH) with masses up to 10 billion solar masses challenge theories of early BH formation and growth, and suggests the existence of direct collapse black holes (DCBHs) with masses >10^4 solar masses as their initial seeds. CR7 (z=6.6) is the brightest Ly alpha emitter ever discovered, with strong HeII emission line and no metal lines, suggesting that it could be the first Population III galaxy formed in a metal-free environment. Alternatively, its properties can also be explained by an AGN powered by a DCBH in the last stage of its accretion at 10^(6-7) solar masses. If it is a DCBH-powered AGN, CR7 is expected to vary at >0.1 mag level in month to year timescales. We propose to carry out new HST/WFC3 F110W and F125W observations in two separate visits. This, combined with archival observations in 2012, will measure the variability of CR7 with rest-frame time lags ranging from 50 days to 300 days. If any significant variability is detected, this will conclusively show that CR7 is a AGN, and is highly likely powered by a DCBH. Its variability property will put a first constraint on models of DCBH accretion; a lack of variability, on the other hand, would strongly suggest CR7 to be powered by Pop-III stars. This modest 4-orbit HST program could help identify either the first DCBH or the first Pop-III galaxy in the early universe, an exciting prospect for future investigations in the JWST era.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14597

Program Title: An Ultraviolet Spectral Legacy of Polluted White Dwarfs

Principal Investigator: Jay Farihi

PI Institution: University College London

Polluted white dwarfs represent the best path to empirically measure the bulk chemical compositions and limiting masses of extrasolar planetesimals. A wealth of data now firmly link metal-enriched white dwarfs with circumstellar debris that derives from rocky planetary building blocks or fragments of larger parent bodies.

Ultraviolet spectroscopy is the only way to detect critical elements such as carbon and oxygen, and the small handful of stars studied in this way have yielded spectacular results. Our recent HST successes demonstrate the power of this technique, and we wish to take the next logical step with a large survey.

In the same way that planetary scientists utilize diverse meteorite classes to understand the formation and composition of the terrestrial planets, we need a statistical census of extrasolar planetesimal compositions to fully understand their physical and chemical role as exoplanet precursors. A large (N ~ 40) dataset of detailed metal abundances in polluted white dwarfs is essential to our understanding of the assembly and chemistry of Earth-like exoplanets.

We propose to observe a brightness-limited sample of metal-rich white dwarfs, by selecting 31 targets that can be observed in a single COS / STIS visit, and thereby making the most efficient use of HST time for any sample of this size. This will increase the number of polluted white dwarfs observed in the far ultraviolet by a factor of five, and thereby perform the most robust and statistically meaningful study that is currently possible.

Proposal Category: AR

Scientific Category: Galaxies

ID: 14562

Program Title: Combining Statistical Samples of Resolved-ISM Simulated Galaxies with Realistic Mock Observations to Fully Interpret HST and JWST Surveys

Principal Investigator: Claude-Andre Faucher-Giguere

PI Institution: Northwestern University

HST has invested thousands of orbits to complete multi-wavelength surveys of high-redshift galaxies including the Deep Fields, COSMOS, 3D-HST and CANDELS. Over the next few years, JWST will undertake complementary, spatially-resolved infrared observations. Cosmological simulations are the most powerful tool to make detailed predictions for the properties of galaxy populations and to interpret these surveys. We will leverage recent major advances in the predictive power of cosmological hydrodynamic simulations to produce the first statistical sample of hundreds of galaxies simulated with 10 pc resolution and with explicit interstellar medium and stellar feedback physics proved to simultaneously reproduce the galaxy stellar mass function, the chemical enrichment of galaxies, and the neutral hydrogen content of galaxy halos. We will process our new set of full-volume cosmological simulations, called FIREBOX, with a mock imaging and spectral synthesis pipeline to produce realistic mock HST and JWST observations, including spatially-resolved photometry and spectroscopy. By comparing FIREBOX with recent high-redshift HST surveys, we will study the stellar build up of galaxies, the evolution massive star-forming clumps, their contribution to bulge growth, the connection of bulges to star formation quenching, and the triggering mechanisms of AGN activity. Our mock data products will also enable us to plan future JWST observing programs. We will publicly release all our mock data products to enable HST and JWST science beyond our own analysis, including with the Frontier Fields.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14800

Program Title: Mapping Calcium Rich Ejecta in Two Type Ia Supernovae

Principal Investigator: Robert Fesen

PI Institution: Dartmouth College

Type Ia supernovae (SNe Ia) are thermonuclear explosions of white dwarfs (WDs) in close binary systems with either a non-degenerate or WD companion. SN Ia explosion computations are quite challenging, involving a complex interplay of turbulent hydrodynamics, nuclear burning, conduction, radiative transfer in iron-group rich material and possibly magnetic fields leading to significant uncertainties. Several key questions about expansion asymmetries and the overall characteristics of SNe Ia could be resolved if one could obtain direct observations of the internal kinematics and elemental distributions of young SN Ia remnants.

We propose to use WFC3/UVIS to obtain images of the normal Type Ia supernova remnant 0519-69.0 and the overluminous Type Ia supernova remnant 0509-67.5 in the LMC. The Ca II on-band F390M filter and off-band F336W and FQ422M filters will be used to determine the spatial extent and density distributions of the Ca-rich ejecta via resonance line absorption. Differences in the observed on and off band Ca II fluxes for LMC stars located behind these young 400 - 600 yr old remnants will yield calcium column density estimates for multiple lines-of-sight within these remnants. These results will be compared to the calcium distribution seen in SN 1885, a subluminous SN Ia in M31, already imaged by HST.

The resulting calcium density distribution maps for both a normal and overluminous SN Ia events will provide powerful insights regarding the structure and kinematics of calcium-rich ejecta in three different type Ia subclass events, and unique empirical data with which to test current SN Ia explosion models.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14801

Program Title: The Mysterious High-Velocity Ejecta Jets in Cassiopeia A

Principal Investigator: Robert Fesen

PI Institution: Dartmouth College

The young Galactic remnant Cas A provides perhaps our clearest look at the explosion of a high mass, core-collapse supernova. Two opposing streams or "jets" of high-velocity debris extending outward along its northeastern and southwestern limbs have expansion velocities more than twice that of the remnant's bright main shell. Interpretation of these NE-SW jets has been controversial. However, SN debris located at the farthest tip of the NE jet has been found to be S,Ar,Ca-rich but O-poor suggesting an origin deep inside the progenitor possibly due to an overturning of layers as predicted in some aspherical explosion models.

Recent WFC3/IR images taken of the NE jet revealed a far richer debris field than previously realized, with ejecta knots found out to the very edge of the camera's FOV. This leaves uncertain the jet's true maximum velocity and total kinetic energy. The lack of a complete census of the jet's structure and kinematics critically limits understanding on the nature of these puzzling kinematic and chemically distinct features. We propose to obtain WFC3/IR images of the remnant's NE jet out beyond existing HST images to complete a survey of its S-rich ejecta and explore the presence of even higher-velocity, Fe-rich ejecta predicted by supernova models. Detection of very high-velocity Fe-rich material in the jet would represent a breakthrough in our understanding of Cas A and core-collapse supernovae in general.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Stellar Physics

ID: 14668

Program Title: Continuing a Snapshot Survey of the Sites of Recent, Nearby Supernovae: Cycle 24

Principal Investigator: Alex Filippenko

PI Institution: University of California - Berkeley

During the past two decades, robotic (or highly automated) searches for supernovae (SNe), most notably our Lick Observatory Supernova Search (LOSS), have found hundreds of SNe, many of them in quite nearby galaxies (cz < 4000 km/s). Most of the objects were discovered before maximum brightness, and have follow-up photometry and spectroscopy; they include some of the best-studied SNe to date. We propose to continue our successful program of imaging the sites of some of these nearby objects, to obtain late-time photometry that will help reveal the origin of their lingering energy. We will also search for possible stellar remnants of Type Iax SNe, an intriguing new possibility. Moreover, the images will provide high-resolution information on the local environments of SNe that are far superior to what we can procure from the ground. For example, we will obtain color-magnitude diagrams of stars in these SN sites, to constrain the reddening and SN progenitor masses. We will search for light echoes around SNe, an important clue to their progenitor systems. We also propose to image some ``SN impostors'' -- faint SNe IIn with massive progenitors -- to verify whether they are indeed superoutbursts of luminous blue variables that survived the explosions or a new/weak class of massive-star explosions.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14685

Program Title: Underlying Hosts or Highly-Kicked? Determining the Nature of Host-less Short Gamma-ray Bursts with HST

Principal Investigator: Wen-fai Fong

PI Institution: University of Arizona

Studies of the environments of short-duration gamma-ray bursts (GRBs) from sub-kpc to galactic scales have provided several lines of indirect observational evidence that short GRBs originate from the mergers of compact object binaries (neutron stars and/or black holes; NS-NS/NS-BH). A fundamental prediction of NS-NS/NS-BH mergers is natal kicks imparted to the systems; thus the locations of short GRBs with respect to their hosts have served as the most crucial diagnostic in solving the progenitor question. One key result that has emerged from these studies is the discovery of a subset of short GRBs which lack coincident galaxies to deep optical and near-IR limits (termed "host-less" bursts). These events either originate from faint underlying low-luminosity or high redshift hosts, or originate from galaxies at large separations of tens to hundreds of kpc (indicative of large kicks). Here, we propose to use HST to obtain deep imaging of six "host-less" short GRBs which have deep ground-based optical limits of >25-26 mag, necessitating the sensitivity of HST. These observations will uncover or place meaningful limits on coincident hosts, providing vital constraints on the true spatial distribution of short GRBs, the fraction of highly-kicked mergers which occur far from their hosts, and will directly inform population synthesis models of compact object mergers, which at present rely on poorly-constrained distributions of kick velocities and delay times. Our proposed WFC3/F110W observations will double the sample of host-less bursts, and are tailored to locate or rule out underlying hosts to a significantly greater depth and redshift than is possible from the ground.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14686

Program Title: Confirming Planetary Mass Candidate Companions in Ophiuchus

Principal Investigator: Clemence Fontanive

PI Institution: Royal Observatory Edinburgh

We propose for follow-up observations to confirm common proper motion for two candidate planetary mass companions, identified as part of our GO 12944 (PI Allers) search for companions to to the youngest (~0.5 Myr) brown dwarfs in the nearby Ophiuchus star-forming region. If confirmed to be co-moving, these would be among the lowest mass planetary mass companions imaged to date, with estimated masses <5 Jupiter Masses and would be vital benchmark objects for evolutionary models at these young ages. With our multi-band optical and IR photometric approach based on the SpT-Q relation seen for Ophiuchus brown dwarfs (Allers in prep.), we have already estimated the spectral type of our candidate companions. This approach distinguishes substellar objects from background interlopers based on the strength of the 1.4 um water feature robustly observed in MLTY objects but not in reddened background stars -- both our candidates show clear evidence of absorption at 1.4 um. If confirmed, these candidate companions would significantly increase the census of young planetary mass companions around extremely young brown dwarfs. These candidate companions are too faint to be observed with ground-based laser guide star adaptive optics (LGS AO) nor is the 1.4 um water feature observable from the ground for such faint objects due to telluric absorption, thus HST is the only telescope in the world suitable for these observations.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO
Scientific Category: Stellar Physics
ID: 14687
Program Title: The Origin of the Leading Arm of the Magellanic Stream

Principal Investigator: Andrew Fox

PI Institution: Space Telescope Science Institute - ESA

A vast debris field of gas connects the Magellanic Clouds and the Milky Way. Known as the Leading Arm (LA), this structure is actively feeding the Galactic disk with new fuel for star formation. Three main concentrations of gas exist, named LA I, LA II, and LA III, but the metallicity has only been measured in one of these three (S/H=0.25+/-0.07 solar in LA II), and the physical connections between the regions are unclear. Here we propose COS FUV spectroscopy of two additional targets (one star and one QSO) that probe LA I and LA III, to map the LA metallicity as a function of position. By comparing the LA chemical abundances in each region we will directly test models of LA formation (single stripping event vs multiple episodes) and therefore constrain the dynamics of the Magellanic System. The observations will also provide measurements of the dust content of the LA via the S/Fe ratio, and the high-ion content via the Si IV doublet, which traces the interaction between the LA and the hot halo of the Milky Way.

Overall, this program will form a case study of the only gas structure accreting onto the Milky Way that can be traced to a neighboring galaxy, and will therefore explore the mechanisms by which galaxies fuel their star formation.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14598

Program Title: The Incredibly Long-Lived SN 2005ip

Principal Investigator: Ori Fox

PI Institution: Space Telescope Science Institute

Type IIn supernovae (SNe IIn) are defined by their relatively narrow spectral line features associated with a dense circumstellar medium (CSM) formed by the progenitor star. The nature of the progenitor and mass loss remains relatively unknown. Shock interaction with the dense CSM can often result in significant UV emission for several years post-explosion, thereby probing the CSM characteristics, progenitor mass loss history and, ultimately, the progenitor itself. The Type IIn SN 2005ip proves to be one of the most interesting and well-studied targets within this subclass. Compared to all other supernovae, SN 2005ip is the most luminous for its age. Now more than 11 years post-explosion, the SN has released >10^51 erg throughout its lifetime as the forward shock continues to collide with a dense CSM. Here we propose HST/STIS-MAMA UV observations of SN 2005ip to investigate the massive CSM. When accounting for the shock travel time, these observations will probe material lost from the progenitor more than 1000 years prior to the explosion. We already have a single HST/STIS spectrum of SN 2005ip from 2014, which was obtained while the shock was still within a higher mass regime. With just 5 orbits, a second spectrum will allow us to directly trace the evolution of the CSM and produce new constraints on the pre-SN mass-loss history. Coinciding with Cycle 24's UV Initiative, this program offers new insight regarding both the progenitor and explosion characteristics of the SN IIn subclass.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14599

Program Title: UV Spectroscopic Signatures from Type Ia Supernovae Strongly Interacting with a Circumstellar Medium

Principal Investigator: Ori Fox

PI Institution: Space Telescope Science Institute

Type Ia supernovae (SNe Ia) are well known for their use as precise cosmological distance indicators due to a standardizable peak luminosity resulting from a thermonuclear explosion. A growing subset of SNe Ia, however, show evidence for interaction with a dense circumstellar medium during the first year post-explosion, and sometimes longer (SNe Ia-CSM). The origin of this dense CSM is unknown and suggests either (a) the less typical single-degenerate progenitor scenario must be considered, or (b) the exploding star was not a thermonuclear explosion of a white dwarf at all (i.e., core collapse). The ultraviolet (UV) offers a unique opportunity to determine the true nature of the SNe Ia-CSM subclass. Unlike optical wavelengths, which can sometimes yield ambiguous classifications, the UV has distinguishing features due to its sensitivity to the composition of the optically thin ejecta that are illuminated by X-rays generated by shock interaction. Yet not a single UV spectrum exists for this subclass. Here we propose a non-disruptive ToO with HST/STIS to obtain 3 epochs (5 orbits each) of UV spectra of a SN Ia-CSM within 100 Mpc. This is a resubmission of a previously approved 2-year program that has not yet been triggered (GO 13649). This program will not only distinguish between the SN explosion mechanisms, but also trace CSM interaction, constrain the progenitor mass loss history, and identify late-time heating mechanisms of warm dust. Coinciding with Cycle 24's UV Initiative, this program offers new insights regarding both the progenitor and explosion characteristics of the SN Ia-CSM subclass.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: ExoPlanets

ID: 14633

Program Title: A SNAP UV Spectroscopic Study of Star-Planet Interactions

Principal Investigator: Kevin France

PI Institution: University of Colorado at Boulder

We propose a SNAP spectroscopic program to survey G and K dwarf exoplanet host stars in the solar neighborhood to characterize the interaction of these stars with their orbiting planetary systems. Stellar and planetary fields may interact for close-in planets, resulting in enhanced stellar activity of the host star and potentially affecting the habitability of planets in the system. A recent study of low-mass stars (France et al. 2016) found evidence for star-planet interactions (SPI) between the stellar transition region/corona and the planets. This work showed a correlation between high-temperature ($T_{form} \gtrsim 10^{5}$ K) stellar emission lines (N V, C IV, and Si IV) and the ratio of planetary mass to the orbital semi-major axis, M_{plan}/a_{plan}. However, that work focused on a limited number of M and K stars. We propose to observe a large number of exoplanet hosting G and K dwarfs to expand the parameter space to a wider range of stellar mass and M_{plan}/a_{plan}. Given the combination of spectroscopic sensitivity and the rich suite of spectral diagnostics in the COS G130M band, this program can be carried out with ~1800 second SNAP observations of G and K dwarf host stars within 50 pc.

Proposal Category: AR

Scientific Category: Stellar Physics

ID: 14563

Program Title: Accretion to Outflow in Evolved Star Binaries: Disks in AGB, PPN and PN

Principal Investigator: Adam Frank

PI Institution: University of Rochester

Collimated mass outflows are a ubiquitous phenomena in astrophysics. While outflows appear to have a common launch mechanism via magneto-centrifugal effects, the source of the mass in the outflows can differ substaintally. In evolved star outflows such as those from Proto-Planetary Nebulae (PPN) and Planetary Nebula (PN), the most likely route to jet production are mass transfer and disk formation in binaries. But unlike other outflow sources such as YSO and AGN, in evolved star outflows the physics of accretion in terms of explicit modes of mass transfer can be hidden under considerable uncertainty. The main goal of this proposal is to shed light on these uncertainties.

We seek to combine HST observations with state of the art numerical simulations tools (developed by our team) to achieve two linked goals in the understanding of evolved star binary mass transfer and their relation to outflow dynamics. (1) to articulate the basic physics of mass transfer and accretion disk formation via a new mechanism called Wind Roche Lobe Overflow (WLROF) as well via wind capture Bondi-Hoyle flows. In this study we will establish limits in terms of accretion rates through the disks and therefore into the jets. (2) to link the disks and accretion flows from our studies to binary systems that have been observed by HST and other platforms such as Mira, the Red Rectangle, M2-9, and He2-90.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14753

Program Title: Supernova 1987A at 30 years

Principal Investigator: Claes Fransson

PI Institution: Stockholm University

This programme will provide a 30 year legacy point for SN 1987A, the brightest supernova since 1604. HST is the essential tool for resolving and analysing SN 1987A's several physical components. The inner, asymmetric ejecta are being heated by X-rays from the circumstellar ring and allow us to directly observe the geometry of the explosion. At the same time the fastest-moving ejecta are interacting with the ring, giving rise to bright emission from shocks. Our latest observations show that the ring is fading and that new spots are appearing outside, signalling that the blast wave has passed the ring and is now interacting with previously unseen material. It is also the beginning of the end for the ring. Here we propose to use COS and STIS to obtain a complete UV/optical spectrum of the ejecta and ring. The spectrum will enable a detailed modelling of the nucleosynthesis, which is a powerful diagnostic of the explosion, and provide a unique opportunity to study a supernova spectrum in the transition phase between a radioactively powered supernova and a shock heated remnant. It will also allow us to distinguish between different excitation mechanisms for the molecular hydrogen, recently discovered in the NIR. We also propose a set of broad and narrow band images to monitor the evolution of the flux and morphology of ejecta, ring and new spots outside the ring. The latter will tell us about the mass-loss history of the progenitor. The proposed observations will provide a crucial complement to recent Herschel and ALMA observations of dust, CO and SiO in the ejecta.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14600

Program Title: SDSS 1240+6710: a partially burnt supernova remnant

Principal Investigator: Boris Gaensicke

PI Institution: The University of Warwick

We have recently (Kepler et al. 2016, Science 352, 6281, April 1 issue) identified SDSSJ124043.01 +671034.68 as a white dwarf with most peculiar characterstics. Instead of the usual hydrogen or helium, its atmosphere is composed almost purely of oxygen, the only other trace elements detected are neon, magnesium, and silicon; and it has a large transverse velocity of ~340km/s. The relatively low mass, 0.6Msun, and the non-detection of carbon strongly argue against SDSSJ1240+6710 being a canonical oxygen-neon core formed from the evolution of a single progenitor star with a mass of ~6.5-10Msun. The detection of silicon suggests that the progenitor of this white dwarf may have initiated oxygen-burning, and we argue that SDSSJ1240+6710 is the partially burnt remnant of an unusual thermonuclear supernova, of which a variety have been discovered by the ongoing large transient surveys. We propose to obtain COS ultraviolet spectroscopy of SDSSJ1240+6710 to measure (1) the abundances of phosphorus and sulfur, two other products of oxygen-burning, (2) significantly improve the upper limits on hydrogen (from Ly alpha) and carbon (1330/1335A resonance lines), (3) probe for traces of other nuclear burning, including nitrogen, iron, and nickel, and (4) accurately measure its effective temperature and mass. SDSSJ1240+6710 provides so far the unique opportunity to test the predictions of the rapidly growing number of theoretical stellar explosion models producing gravitationally bound remnants.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Blackholes

ID: 14728

Program Title: Hearts of Darkness: Compact Obscured Nuclei in S0/a Galaxies

Principal Investigator: John Gallagher

PI Institution: University of Wisconsin - Madison

Recent high angular resolution millimeter observations have revealed extrordinary features in the centers of nearby S0/a galaxies. These nuclei are compact (< 100 pc) and heavily obscured by ~1E7-1E8 Msun of dense, dusty gas at levels that challenge ALMA. The three archetypal compact obscured nuclei (CONs) that we are targeting for HST UVOIR imaging are luminous FIR sources without obvious starbursts which suggests that the CONs are associated with AGN in a previously unrecognized type of SMBH growth phase. Our molecular line observations detect substantial molecular inflows and outflows from our targeted CONs, including a highly collimated molecular jet in NGC 1377; these systems are in dynamic states with significant momentum transfers within their gas. Because of the challenges associated with directly observing CONs even at millimeter wavelengths, these objects are best studied through their effects on the surrounding environment. Thus, we propose to obtain WFC3 HST imaging in the UVOIR to extend our understanding of the relationship between CONs and their host systems. The primary objectives of this HST project include measuring dust absorption to map the 3D structure of the ISM out to kiloparsec scales and to thereby constrain the mechanisms responsible for the dynamic behavior of the gas. The unique resolution and wavelength coverage of WFC3 images also will allow us to explore dust-to-gas ratios and CO-H2 conversion factors, assess the levels of recent star formation and seek evidence of past galaxy interactions which might produce CONs in otherwise quiescent galaxies.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14729

Program Title: A New Twist in the Quasar Radio Dichotomy: The Case of the Missing Outflows

Principal Investigator: Rajib Ganguly

PI Institution: University of Michigan

An inspection of quasar spectra taken with COS/G130M or G160M reveals a curious result. While 39/146 radio-quiet quasars show intrinsic N V absorption, thought to trace the quasar outflow, absolutely none of the 19 radio-loud quasars show N V absorption. Essentially all of the radio-loud quasars for which N V absorption can be detected have compact morphologies as sampled by FIRST 1.4 GHz imaging and comparatively flat radio spectra. This implies that we are viewing more face-on orientations which bias us against seeing outflows in absorption. Alternatively, it could be that the structure of quasar winds in radio-loud objects are just fundamentally different than radio-quiet objects. To distinguish between these possibilities, we have assembled a sample of 15 low-redshift SDSS quasars which show lobe-dominated FIRST morphologies, and are UV bright enough to be observable with COS. Four objects have suitable observations in the archive, so we ask to observe the remaining 11.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Galaxies

ID: 14564

Program Title: Reconstructing Star Formation Histories to Reveal the Origin and Evolution of the SFR-M* Correlation

Principal Investigator: Eric Gawiser

PI Institution: Rutgers the State University of New Jersey

Correlations have played an important role in advancing our knowledge of astrophysics, from the Schmidt-Kennicutt law to the black hole-bulge mass relation. A surprisingly tight correlation between galaxy star formation rates (SFR) and stellar masses (M*) was discovered in 2007, and models of galaxy formation and evolution can be constrained by studying the evolution of this SFR-M* correlation and its intrinsic scatter. At present, such investigations are weakened by the need to assume a simple parametric form for the star formation history, typically constant or exponentially declining.

We propose to use our new dense basis method to reconstruct star-formation histories (SFHs) through SED fitting using multi-band photometry of >10,000 galaxies in the 3D-HST and CANDELS catalogs. Armed with these reconstructed SFHs, we will then:

1. Better measure the SFR-M* correlation (aka star-forming sequence) in several redshift bins at $0.5<z<3$. Properly accounting for SFH uncertainties will generate improved measurements of intrinsic scatter.

2. Determine trajectories by which galaxies observed at a given epoch arrived at their current coordinates in SFR-M* space, allowing us to evolve the correlation back in time to previous redshift bins. The fraction of star-forming galaxies found to remain on the correlation between epochs will determine the level of stochasiticity driving star formation in galaxies.

Proposal Category: AR

Scientific Category: Galaxies

ID: 14565

Program Title: Understanding the Angular Momentum Content of Galaxies in Concert with Their Circumgalactic Medium

Principal Investigator: Shy Genel

PI Institution: Columbia University in the City of New York

Legacy observations with HST have enabled fundamental measurements in galaxy formation: the angular momentum of galaxies and the physical state of the circumgalactic medium (CGM). These measurements still require theoretical interpretation in the context of a comprehensive galaxy evolution model. Cosmological hydrodynamical simulations provide this context, and recent ones have reproduced these measurements fairly well, primarily thanks to sub-grid models of strong feedback from star-formation and black holes. In addition to their relation through a common sensitivity to feedback processes, the angular momentum of galaxies and properties of their CGM are also related by direct causality: the internal angular momentum of a galaxy is provided by accretion of angular momentum from its CGM, and is affected by torques exerted by it. Here, we propose to combine these two topics for the first time and interpret these important observational contributions of HST within a unified theoretical framework based on the Illustris simulation suite. These simulations contain large galaxy populations (thousands of L* galaxies), reproduce the main observed features of angular momentum and CGM of L* galaxies, and include a comprehensive model for feedback processes. We will study how feedback prevents the 'angular momentum catastrophe' by performing an in-depth Lagrangian analysis of CGM gas flows, and study the kinematics of the gas in concert with its chemical and ionization state to compare to observations. The analysis of the link between the CGM and angular momentum in simulations will shed light on the formation history of the observed CGM and its ongoing role in galaxy evolution.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14778

Program Title: Hiding in Plain Sight: The Low Mass Helium Star Companion of EL CVn

Principal Investigator: Douglas Gies

PI Institution: Georgia State University Research Foundation

Binary stars with orbital periods of a decade or less are destined to interact during their evolution. The mass donor star among intermediate binaries may be stripped of its envelope by mass transfer to reveal its helium core. In cases that avoid merger, the low mass helium star will remain in a binary orbit but be lost in the glare of the mass gainer star. Thanks to photometric time series from Kepler and WASP, we now know of 27 such systems that are oriented to produce mutual eclipses. Although the helium star companions are too small and faint in the optical band for spectroscopic detection, they contribute a larger fraction of the total flux in the ultraviolet. HST/COS measurements of one long period system, KOI-81, successfully detected the helium star's spectrum in the far-ultraviolet, leading to estimates of its mass and temperature. Here we propose to obtain new HST/COS FUV spectra of the prototype of this class of evolved binaries, EL CVn, and to determine the mass and physical properties of a star that barely escaped a merger.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14706

Program Title: Testing the Triggering Mechanism for Luminous, Radio-Quiet Red Quasars in the Clearing Phase: A Comparison to Radio-Loud Red Quasars

Principal Investigator: Eilat Glikman

PI Institution: Middlebury College

We propose to conduct a controlled study of the relationship between radio emission and host galaxy morphology for a new sample of radio-quiet dust-reddened quasars selected by their infrared colors in WISE and 2MASS (W2M). These sources are the radio-quiet analogs to the FIRST-2MASS (F2M) red quasars, which we found to be predominantly driven by major mergers. F2M red quasars are accreting at very high rates and exhibit broad absorption lines associated with outflows and feedback. Their properties are consistent with buried quasars expelling their dusty shrouds in an an evolutionary phase predicted by merger-driven co-evolution models. The quasars in both samples are the most intrinsically luminous objects in the Universe -- the regime where we expect mergers to dominate. However, recent lines of evidence suggest that radio emission may be linked to AGN reddening and merging hosts.

We will use WFC3/IR and ACS to image the host galaxies of W2M quasars in the two redshift regimes that our previous studies probed, z~0.7 and z~2, testing the merger-driven quasar paradigm across the full radio range with a minimum of selection effects or other biases that plague many studies comparing different samples. The images proposed here will sample the host galaxies in rest-frame visible and UV light to look for merger signatures. Evidence for mergers in these quasar hosts would support a picture in which luminous quasars and galaxies co-evolve through major-mergers, independent of their radio properties. The absence of mergers in our data would link radio emission to mergers and require an alternate explanation for the extreme properties of these radio-quiet sources.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14688

Program Title: Extended Star Formation or a Range of Stellar Rotation Velocities? The Nature of Extended Main Sequence Turnoffs in Intermediate-Age Star Clusters

Principal Investigator: Paul Goudfrooij

PI Institution: Space Telescope Science Institute

Recently, deep color-magnitude diagrams (CMDs) from HST data revealed that several massive intermediate-age star clusters in the Magellanic Clouds exhibit extended main-sequence turn-offs (eMSTOs), and in some cases also dual red clumps. This poses serious questions regarding the mechanisms responsible for the formation of massive star clusters and their well-known light-element abundance variations. The nature of eMSTOs is currently a hotly debated topic of study. Several recent studies indicate that the eMSTOs are caused by an age spread of about 100-500 Myr among cluster stars, while other studies indicate that eMSTOs can be caused by a coeval population in which the relevant stars span a range of rotation velocities. Formal evidence to (dis-)prove either scenario still remains at large, mainly because the available stellar tracks that incorporate the effects of rotation are only available for masses > 1.7 Msun whereas the stars in the known eMSTOs of intermediate-age clusters are less massive. To circumvent this issue, we identified a massive star cluster in the Large Magellanic Cloud (LMC) that has the right dynamical properties to host an eMSTO along with an age at which the effects of age spreads to CMD morphology are substantially different from those of spreads of rotation rates: the ~600 Myr old cluster NGC 1831. We propose to obtain deep WFC3/UVIS imaging with filters F336W and F814W to analyze the morphologies of the MSTO and upper MS regions of NGC 1831 at high precision and compare with model predictions. This will have a lasting impact on our understanding of the eMSTO phenomenon and of star cluster formation in general.

Proposal Category:	GO
Scientific Category:	Blackholes
ID:	14730
Program Title:	High spatial resolution imaging of AGN-driven super-bubbles in two low-redshift quasars
Principal Investigator:	Andrew Goulding
PI Institution:	Princeton University

The impact of active galactic nuclei on gas dynamics and star formation holds immense implications for galaxy formation models. We propose high spatial resolution HST imaging observations of SDSS J1000+1242 and SDSS J1010+1413, two luminous obscured AGN that seemingly host powerful galaxy-scale outflows indicative of on-going radiatively-driven feedback. Based on our previous long-slit spectroscopy with Magellan IMACS, the high velocity (~1000km/s) outflows in these objects are extended on 5-10 kpc scales, and hence, are capable of strong interactions with the host galaxy. Analogous to SDSS J1356+1026, which we have previously confirmed to have spatially resolved hot X-ray emitting gas regions coincident with [OIII] emission, both our targets likely host ionized gas super-bubbles. Our proposed observations will provide morphologies of the ionized gas outflows seen in [OIII] emission, as well as measurements of the scattered light fraction that provides crucial information for determining the total gas mass and energetics of the outflows. When combined with previous multi-wavelength data, these observations will allow a complete multi-phase, multi-scale investigation of AGN feedback, and the ability to test the coupling of outflowing material and the central AGN.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14689

Program Title: MYSST: Mapping Young Stars in Space and Time - The HII Complex N44 in the LMC

Principal Investigator: Dimitrios Gouliermis

PI Institution: Zentrum fuer Astronomie der Universitaet Heidelberg

The stellar initial mass function (IMF), and the timescale and lengthscale of star formation (SF) are critical issues for our understanding of how stars form. Low-mass pre-main-sequence (PMS) stars, having typical contraction times on the order of a few 10 Myr, are the live chronometers of the SF process and primary informants on the low-mass IMF of their host clusters. Our studies show that young star clusters, embedded in star-forming regions of the Large Magellanic Cloud (LMC), encompass rich samples of PMS stars, sufficient to study clustered SF in low-metallicities with optical HST photometry. Yet, the lack of a complete comprehensive stellar sample retains important questions about the universality of the IMF, and the time- and length-scale of SF across a typical molecular cloud unanswered. We propose to address these issues by employing both ACS and WFC3 with their high sensitivity and spatial resolving power to obtain deep photometry (m_555~29 mag) of the LMC star-forming complex N44. We will accomplish a detailed mapping of PMS stars that will trace the whole hierarchy of star formation springing from one giant molecular cloud. Our analysis will provide an unbiased determination of the timescale for SF and the sub-solar IMF down to the hydrogen burning limit in a variety of clustering scales for the first time. Our findings will have a significant impact on our comprehensive understanding of SF in the low-metallicity environment of the LMC. We maximize the HST observing efficiency using both ACS/WFC and WFC3/UVIS in parallel for the simultaneous observations of N44, its ensemble of HII regions and their young stellar clusters in the same F555W and F814W filters.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Stellar Physics

ID: 14779

Program Title: A NUV Imaging Survey for Circumstellar Material in Type Ia Supernovae

Principal Investigator: Melissa Graham

PI Institution: University of Washington

We propose a new SNAP program to evaluate the occurrence of interaction between putative circumstellar material (CSM) and the ejecta of Type Ia supernovae (SNe Ia) using NUV imaging at >1 year after explosion. CSM is predicted to exist for up to 20% of SNe Ia, but has only been confirmed for a small number events in which we catch the SN ejecta interact with the CSM. This discrepancy may be due to CSM commonly residing at large radii, in which case the ejecta only interacts at >1 year after explosion, and/or because the signature of interaction is clearest in the NUV, as no late-time NUV SN Ia survey has yet been initiated. Our proposed NUV snapshot survey targets a subset of local-universe SNeIa that are most likely to have a progenitor system with CSM, and requires only one 20 minute duration visit per target. These NUV images will assess prevalence, radius, mass and composition of CSM in SN Ia systems, and help to constrain the progenitor models for these valuable cosmological standard candles.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14611

Program Title: Going gently into the night: constraining Type Ia supernova nucleosynthesis using late-time photometry

Principal Investigator: Or Graur

PI Institution: New York University

We propose to use WFC3 photometry to construct the optical light curves of the nearby Type Ia supernovae SN 2015F and ASASSN-14lp at late times (>500 days after maximum light). These light curves will allow us to conduct a fundamental test of the theoretically predicted behavior of Type Ia supernova light curves at late times. We will observationally determine whether the nuclear physics of Type Ia supernova ejecta are solely determined by the radioactive decay of 56Co to 56Fe, or whether (and by how much) other nuclear heating mechanisms (such as the leptonic decays of 57Co) become discernible, as predicted. The spatial resolution of HST+WFC3 is crucial to the success of this experiment. At these late times, the fading supernovae are as bright as other surrounding objects (bright stars, star clusters), which would dominate the point-spread functions of ground-based observatories. Due to the rarity of nearby Type Ia supernovae, this experiment will double the sample of supernovae for which this experiment has been conducted and cut the uncertainty on the results by half. Moreover, if this experiment is not conducted in Cycle 24, it is highly unlikely that we would be able to perform it again during the remaining lifetime of HST.

Proposal Category: GO

Scientific Category: Solar System

ID: 14634

Program Title: HST-Juno synergistic approach of Jupiter's magnetosphere and ultraviolet auroras

Principal Investigator: Denis Grodent

PI Institution: Universite de Liege

Jupiter's system is not only fundamental to our understanding of the solar system but also of planetary systems around other stars as well as more distant astrophysical bodies, not accessible to a detailed investigation. Fully exploiting any rare opportunity to explore the Jovian system through synergistic observations is thus critical, as it will impact significantly across wider astronomical studies. Such an exceptional opportunity will occur in Cycle 24, when the NASA Juno spacecraft will achieve its prime mission around Jupiter. Since Juno will literally fly through the auroral acceleration regions, the combination of HST auroral observations with Juno in situ measurements will allow us to finally unravel the origins and consequences of Jupiter's powerful and highly variable ultraviolet auroras. This occasion has never occurred before and is unlikely to ever repeat.

Juno will address key scientific issues related to unexplored regions of the Jovian magnetosphere. The auroral signatures associated with these magnetospheric processes will be precisely observed with STIS and COS. This program responds to the UV initiative and is only possible during Cycle 24. Indeed, HST is the only observatory capable of making these high spatial and temporal resolution FUV observations during the Juno mission. This ambitious campaign will yield high-impact results and significantly augment the science return of the NASA Juno mission.

Proposal Category:	GO
Scientific Category:	Stellar Physics
ID:	14780
Program Title:	Measurement of the Expansion Proper Motions of the Ou4 Giant Bipolar Outflow to Determine its Distance and its True Nature
Principal Investigator:	Nicolas Grosso
PI Institution:	Universite de Strasbourg I

Ou4 is a giant bipolar outflow with a total length of 1.2 degrees on the sky that was discovered in the optical in the direction of the blister HII region Sh2-129. The distance, the nature, and the driving source of Ou4 are, however, not known. Ou4 is relevant for the study of the eruptive phenomena producing collimated outflows from evolved low-mass binary stars and young, massive stellar systems. Our morpho-kinematics study of the Ou4 south bow-shock has allowed us to predict its expansion proper motion that is directly related to its distance. We propose to image the brightest [O III] emission of this bow-shock with the UVIS channel of the WFC3 in Cycle 24 and 26 in order to determine the distance of this largest known stellar bipolar outflow from its expansion proper motions. This measurement is crucial to determine the true nature of Ou4: either a foreground planetary nebula or a giant bipolar outflow launched ~90,000 years ago by HR 8119, the young massive triple system ionising Sh2-129.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14690

Program Title: Identifing the last unkown emission component in the Herbig system HD 163296

Principal Investigator: Hans Guenther

PI Institution: Massachusetts Institute of Technology

The HAeBe star HD 163296 is surrounded by a circum-stellar accretion disk and drives a highly-collimated jet. It was observed four times in the UV with HST/STIS long-slit spectroscopy; in all cases the slit was oriented along the jet. These observations discovered extended, red-shifted Ly alpha emission of unknown origin on the same side of the star as the blue-shifted jet. We propose to explore the origin of this component using three new STIS G140M long-slit exposures with different position angles. This allows us to differentiate three scenarios for the emission: (i) dust scattering in the jet, (ii) dust scattering in the disk and (iii) a very fast disk wind. Case (i) would show that the jet is a collimated disk wind, not a stellar wind, (ii) would imply that the Ly alpha emission comes from magnetically funneled accretion and (iii) would prove that the disk wind is an order of magnitude faster than expected from photo-evaporation models. Each of these results would constitute a major step in our understanding of intermediate mass star formation.

Proposal Category: AR

Scientific Category: Stellar Physics

ID: 14566

Program Title: Constraining Theroretical Wind Models using the Accelerating Outflows of Cool Evolved Stars as revealed by Hubble

Principal Investigator: Graham Harper

PI Institution: University of Colorado at Boulder

The vacuum ultraviolet (UV) contains many strong transitions of neutral and singly ionized atomic species that allow the outflows (winds) from cool evolved stars to be mapped through their scattering line profiles. The high spectral resolution and high signal-to-noise ratios, and excellent noise characteristics of Hubble spectra permit the study of the poorly understood processes that drive outflows from red giant stars. The high spectral resolution has revealed that the outflows have low intrinsic UV emission and they accelerate with velocities systematically increasing outwards, rather than occurring through ballistic ejections from the surface.

HST spectra have provided numerical constraints on wind speeds, turbulence, and mass-loss rates but they have not been fully exploited to study the important underlying physics of the wind driving process. We propose a study, within the framework of wave-driven outflows, to infer the radial wave-pressure gradients required to drive the observed winds and derive implied heating rates for well-studied single red giants. These will be used to study magnetic wave frequencies, flow geometries, damping mechanisms, and thus provide new physical insights into the poorly understood mass loss process. The results will also provide improved constraints for physically motivated mass-loss rate expressions for use in stellar evolution codes.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14731

Program Title: Si I and C I emission from zeta Aurigae (K4 Ib + B5 V): New Generation Diagnostics of Chromospheric Structure

Principal Investigator: Graham Harper

PI Institution: University of Colorado at Boulder

Zeta Aur eclipsing binaries provide the most detailed spatial information about the extended atmospheres of red supergiants. During chromospheric eclipse phases quantitative information about densities, temperatures, turbulence, and ionization have been obtained. However, detailed information about the atmosphere can also be obtained away from eclipse when the hemisphere illuminated by the ultraviolet continuum of the companion is visible from Earth. New Si I and C I diagnostics can provide spatially-resolved information on the velocity fields in the deepest layers yet measured for a K4 Ib star .

We propose to observe the zeta Aurigae system with STIS at three orbital phases to study the velocity fields and ionization balance using the Si I and C I emission feautures. zeta Aurigae has a 972 day period and the next eclipse is in March 2017. This may be the last opportunity to study this benchmark system for studying the atmospheres of cool evolved stars.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14601

Program Title: The Energetically Complete Picture of a Starburst Superwind

Principal Investigator: Matthew Hayes

PI Institution: Stockholm University

Recent Cycle 22 observations, with both ACS and COS, have revealed a halo of OVI emission surrounding a low-redshift, compact star-forming galaxy. This is the first time that the coronal gas phase, with the illusive temperature of T~300,000 K, has been mapped in emission for an individual galaxy. The implications of this are profound, in that this gas may represent the hitherto unobservable temperature regime through which galaxy superwinds can radiate energy. These unique observations enable us measure a large number of properties of the warm outflow, but the global properties of the wind in all other gas phases remain illusive because few suitable metal lines are available in the existing COS/G130M spectrum.

We propose to obtain COS spectroscopy in the redder G160M setting to measure the absorption features of 10 more interstellar lines. From this we will build a picture of the velocity structure of the outflow in the colder atomic phases that are likely to contain the bulk of the mass. This will provide the complete energetic picture of the outflow, including warm/coronal and colder/atomic phases for the first time. A further G130M spectrum positioned in the halo will determine the properties (flux and kinematics) of a peculiar 'blob' of enhanced OVI emission. This region is as bright in OVI as the central pointing, but is located 10 optical scale lengths from the center, with no obvious cospatial source of excitation. Kinematics derived from this observation will determine its physical origin.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14691

Program Title: Unraveling the oscillations of the richest pulsating hydrogen-atmosphere white dwarf

Principal Investigator: JJ Hermes

PI Institution: University of North Carolina at Chapel Hill

Most stars in our Galaxy will end or have already ended their lives as white dwarf stars, making them important benchmarks for stellar evolution. Here we propose to obtain COS far-ultraviolet spectroscopy of a pulsating hydrogen-atmosphere white dwarf (DAV) with extensive, space-based photometry obtained by the Kepler spacecraft during the K2 mission. The pulsation spectrum is the richest of any DAV collected to date, but to extract any information about the white dwarf interior we must identify the spherical degree (l) of the modes present. Our time-tagged ultraviolet observations will enable us to identify the spherical degree of the highest-amplitude pulsation modes, since the ratios of the ultraviolet-to-optical pulsation amplitudes strongly depend on the geometry of the pulsation modes. This will decisively determine if most of the modes present are a series of l=3 modes, as it appears from the frequency multiplets in the K2 data; however, l=3 modes have never been clearly identified in a pulsating white dwarf. Our far-ultraviolet spectroscopy, covering the H2/H2+ quasi-molecular satellites around 1400 and 1600 AA, will also measure the white dwarf temperature and mass to an accuracy unachievable from the ground. This robust temperature and mass will anchor our detailed asteroseismic investigation of this stellar remnant. The unique combination of HST and Kepler observations will make this white dwarf a benchmark for the unprecedented opportunities for white dwarf archaeology enabled by the original Kepler mission and its extension into the ecliptic, K2.

Proposal Category: AR

Scientific Category: IGM and COS

ID: 14567

Program Title: Inferring the mass function and galaxy content of low mass subhalos with HST observations of ALMA strong lensing systems

Principal Investigator: Yashar Hezaveh

PI Institution: Stanford University

The abundance, properties, and stellar contents of the smallest dark matter halos hold essential clues to our understanding of the nature of dark matter and the physics of galaxy formation on the smallest scales. ALMA observations of strongly lensed galaxies are now allowing us to detect low-mass subhalo satellites of distant galaxies. Comparing these measurements to theoretical models, however, requires a detailed knowledge of the host halo, which can be obtained from HST observations of the lensing systems. We propose to perform simulations of the stellar populations of the host halos and their subhalos and to develop an analysis pipeline to determine how HST observations could be efficiently planned and used to (1) place stringent constraints on the properties of host halos and (2) to measure the stellar mass contents of the lensing detected subhalos. The result of this study will enhance the synergy between HST and ALMA observations to answer fundamental questions about the nature of dark matter and the process of galaxy formation on small scales.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Physics

ID: 14568

Program Title: Spectroscopic Analysis: A Key Tool for Understanding the Universe

Principal Investigator: D. Hillier

PI Institution: University of Pittsburgh

Spectroscopic analysis is a key tool for understanding the nature of stars and supernovae. To facilitate advances in spectroscopic analysis we will significantly enhance and extend the capabilities of our time-dependent radiative transfer code, CMFGEN. As part of these improvements we will expand one of the associated codes to handle complex photospheric velocity fields, and we will investigate and test new methods to better treat multi-component winds. CMFGEN has been extensively used to study luminous blue variables, O stars, Wolf-Rayet stars, [W-R] central stars of planetary nebulae, and most types of supernovae. All these objects have been extensively observed by HST. CMFGEN, with documentation and sample models, is available at www.pitt.edu/~hillier.

O stars, and their descendants, play a crucial role in galaxy evolution. They are a dominant source of ionizing radiation, and through their winds and supernovae explosions they deposit momentum and energy into the interstellar medium. They are also responsible for many of the key elements (e.g., O, Mg, Si) necessary for life. Despite advances we still lack a firm understanding of massive star evolution: What is the role of rotation in massive star evolution and how does it change with metallicity? How does rotation affect surface abundances? What is the origin of turbulence in massive stars? How does the supernova subtype correlate with a star's initial mass? What is the relative importance of single stars compared with binary systems for producing Wolf-Rayet stars and supernovae? We can address many of these questions (or at least provide important constraints) by performing accurate spectroscopic analyses.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14802

Program Title: Synoptic Imaging Polarimetry Observations of CRL 2688: What's Whipping the Egg?

Principal Investigator: Dean Hines

PI Institution: Space Telescope Science Institute

We propose to obtain new imaging polarimetry of the archetypical pre-planetary nebula, CRL 2688 (The Egg Nebula) with the ACS/WFC in the F606W and F775W filters. Pre-planetary nebulae are objects caught in the short-lived, rapidly changing transition phase between the AGB and planetary nebula (PN) stages of stellar evolution. Their morphology bridges the gap between the spherical mass-loss of AGB stars and the surprisingly non-spherical morphologies observed in PN. The mechanism(s) that drives this departure from sphericity is highly debated, and has many implications for stellar and galactic evolution. CRL 2688 is the nearest (to Earth) pre-planetary nebula. Its complex morphology exhibiting lobes, rings, "search light beams," and a dust lane -- all of which shine in highly polarized light -- make it an ideal specimen for detailed investigation with the high spatial resolution and exquisite polarimetric precision and accuracy provided by HST/ACS. Our proposed observations will be compared with previous ACS imaging polarimetry obtained in 2002 (providing a ~14 year baseline) to: 1) look for secular changes in properties of the scattering particles and scattering geometries within the lobes, rings, SLBs and dust lane; 2) form perpendiculars to the polarization position angles to pinpoint the location of the central illuminating source -- comparison between epochs will place constraints on changes in that source; 3) precisely measure proper motions in the lobes, SLBs, and rings. Our results will provide new insights into the processes that transform the spherical envelopes of a dying low mass stars into the often highly aspherical structures witnessed in planetary nebulae.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14669

Program Title: Ultramassive Black Holes in Brightest Cluster Galaxies

Principal Investigator: Julie Hlavacek-Larrondo

PI Institution: Universite de Montreal

We have identified an exceptional brightest cluster galaxy (PKS0745-BCG, z=0.1028) which stands out as being located in one of the most massive and strong cool clusters know, yet has clear rotation of the gas within the central regions of the galaxy to enable modelling of the black hole mass. Our results imply that the black hole mass should be at least 2.5*10^10Msun, but can be as high as 10^11Msun, placing it well above the observed correlation between central black hole mass (M_BH) and bulge stellar velocity dispersion (sigma). It should therefore host the most massive black hole in the Universe, even when compared to other BCGs. We propose to measure its black hole mass using long-slit spectroscopy from STIS onboard HST. There are only four black holes with masses exceeding 10^10Msun known so far. The high-mass end of one of the most fundamental relations in astronomy, the M_BH-sigma relation, therefore remains unconstrained. Careful study of black holes with masses in excess of 10^10Msun is the only way forward to complete our understanding of M_BH-sigma relation. This is the goal of our proposal.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14732

Program Title: 2MASS J00423991+3017515: An AGN On The Run?

Principal Investigator: James Hogg

PI Institution: University of Maryland

We have discovered a peculiar AGN, 2MASS J00423991+3017515, in a local (z=0.14), disturbed galaxy whose optical spectrum has multiple broad lines that are consistently offset from the narrow line emission and host galaxy absorption by 1530 km/s. The morphology of the host galaxy and spectral properties thus suggest this AGN may be a recoiling supermassive black hole (SMBH). Gravitational-wave recoil kicks result from the coalescence of two SMBHs and have implications for the early growth of high-redshift quasars and SMBH-galaxy co-evolution. We propose high-resolution imaging in the NIR, optical, and UV with the WFC3 camera on Hubble and high-resolution X-ray imaging and spectral follow-ups with the ACIS camera on Chandra to determine if the source of the kinematically-offset broad line emission is also spatially offset from the nucleus of the host galaxy. We request 3 orbits with Hubble and 8 ksec with Chandra to conduct these follow-up observations. If a single, spatially offset AGN is detected, this source will be strongest candidate for a recoiling AGN candidate discovered to date, providing a new, indirect constraint on SMBH spin evolution and merger rates.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 14652

Program Title: Super-Eight: The brightest z~8 Galaxies

Principal Investigator: Benne Holwerda

PI Institution: Sterrewacht Leiden

What are the properties of the most massive z~8 galaxies ("Super-Eights") and how luminous can these galaxies become at that epoch? Answering these questions is challenging due to the rarity of luminous z~8 galaxies and the large field-to-field variations in their volume densities. Indeed, the full wide-area CANDELS program only shows 3 z~8 galaxy candidates brighter than 25.5 mag and all of these candidates conspicuously lie in the same CANDELS field (EGS).

One of our strongest new probes for particularly luminous z~8 galaxies are the WFC3 Pure-Parallel (PP) programs. Particularly intriguing are 8 bright z~8 candidates in these observations. These candidates have similar luminosities as the 3 brightest z~8 candidates from CANDELS (all spectroscopically confirmed). However, the uncertain contamination levels at extreme bright end of z~8 selection mean that follow-up observations are critical. We propose highly-efficient pointed HST and Spitzer/IRAC observations to determine if these candidates are indeed at z~8. We estimate that anywhere from 50 to 100% of the targeted sources will be confirmed to be at z~8 based on our results from CANDELS. The estimate is very uncertain due to very large cosmic variance in the CANDELS result and contamination from rare low-redshift sources.

When combined with CANDELS, our observations would provide us the strongest current constraints on the volume density of bright, massive galaxies in the early Universe (serving as a guide to models of their build-up) and also provide valuable targets for future spectroscopy (e.g. with JWST), useful for probing the

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14733

Program Title: Single-Degenerate or Double-Degenerate? The Case for a Third Epoch Observation of the Confirmed Ia Supernova Remnant 0509-67.5

Principal Investigator: Luke Hovey

PI Institution: Los Alamos National Laboratory

Observations of Ia supernovae have been invaluable in measuring distances on cosmological scales and led to the discovery of the accelerating universe. Even though it is accepted that these supernovae are the result of thermonuclear explosions of accreting white dwarf stars, little is known on the progenitor systems. One important tool in constraining these systems is the observations of supernova remnants. The remnant 0509 -67.5 is of particular interest in this endeavor due to its remarkably circular structure and being situated in the Large Magellanic Cloud (LMC). Being located in the LMC, we know the distance to this remnant to greater accuracy than any of the galactic remnants. This enables us to translate the proper motion measurements of the forward shock into physical units of velocity, which we have done in Hovey et al. (2015). Using these measurements we are able to assess a dynamical offset of the explosion site from the geometric center of the remnant in the east-west plane. Unfortunately we are unable to make this measurement in the north-south plane due to our second epoch observation being imaged with the WFPC2 camera after the ACS camera failed. We are requesting a third observation of 0509-67.5 with the ACS camera so we can fully constrain the search radius for a possible surviving companion star. With a third epoch observation, we will be able to measure the proper motions around the entire rim to with much higher precision than those in Hovey et al. (2015) and place the best constraint on possible progenitor companion. This measurement is not technically challenging, but will deepen our knowledge of the progenitor systems of Ia supernovae.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14602

Program Title: The Perseus Project: Probing Metal Mixing, Dust Destruction, and Kinematics in the Vertical Extension of the Perseus Arm

Principal Investigator: J. Howk

PI Institution: University of Notre Dame

We propose to use high-resolution STIS absorption spectroscopy of bright stars to probe the vertical structure of gas in the Perseus arm of the Milky Way. We will target 5 stars in 2 vertical stripes, probing the high-z extension of the Perseus arm to z~1.7 kpc. Our proposed observations will provide the first measurement of vertical abundance gradients in the gas of the Milky Way -- which will constrain the mixture of fountain-driven outflows compared with cooled gas from the metal-poor Galactic corona. We will quantify changes in the dust composition and kinematics with z-height in the Perseus arm, and we will quantify the relative masses of the cool, warm (neutral and ionized), and warm-hot phases of the ISM with height. Our proposed program will provide direct measurements of the vertical metal mixing scales in the Milky Way, and it will limit the degree to which the Milky Way is tapping its corona for new material for star formation, both important in the larger context of galaxy evolution.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14635

Program Title: Lyman continuum leaking in luminous compact star-forming galaxies

Principal Investigator: Yuri Izotov

PI Institution: Ukrainian National Academy of Sciences, MAO

One of the key questions in observational cosmology is the identification of the sources responsible for cosmic reionization. The general consensus is that a population of faint low-mass galaxies must be responsible for the bulk of the ionizing photons. However, until recently, attempts at identifying individual galaxies showing Lyman continuum (LyC) leakage have only found very few such galaxies, both at high and low redshifts. A breakthrough was recently achieved by Izotov et al. (2016ab), who detected LyC emission in five out of five low-redshift (z~0.3) luminous compact star-forming galaxies (LCGs) with robust LyC escape fractions of 6 -13%, using HST/COS observations. This high success rate is presumably due to the new selection criteria, based primarily on compactness and on a high [OIII]5007/[OII]3727 (O32) ratio. Furthermore these galaxies show narrow Lya line profiles, confirming our predictions for LyC leakers. Based on this success we now propose to extend our study to six LCGs at z~0.3-0.4 with extreme O32~9-23, a range which has never been observed with HST. This will allow us to determine if they are also LyC leakers as expected from their high O32, and if the LyC escape fraction continues to rise with increasing O32, as indicated by the sources with existing LyC detections. Finally the requested COS observations will allow us to measure for the first time the Lya line profile of such extreme objects, providing thus an empirical probe of this indirect LyC leakage indicator. Since the LCGs share many properties with typical star-forming galaxies at high redshift our study will provide important insight on the sources of cosmic reionization.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Galaxies

ID: 14569

Program Title: All about that Base: Baseline Metal Enrichment from Population III Star Formation in Cosmological Simulations

Principal Investigator: Jason Jaacks

PI Institution: University of Texas at Austin

We propose to use a new suite of mesoscale cosmological volume simulations with custom built sub-grid physics to study the baseline metal enrichment in the interstellar medium of the first galaxies resulting from Population III star formation. Determining this baseline metal enrichment will allow us to place a lower limit constraint on the UV spectral slope Beta due to metal enrichment, which can be directly applied to current and future frontier high redshift observations (i.e z>10). A robust lower limit on Beta allows us to place a lower limit on the local extinction value (i.e. dust) and thus the intrinsic luminosity and star formation rate of primordial galaxies.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14603

Program Title: Ulraviolet fluxes and dynamical structure in the pulsating atmosphere of helium star V652 Her

Principal Investigator: C. Jeffery

PI Institution: Armagh Observatory

V652 Her is a B-type extreme helium star which pulsates with a period of 154 minutes and a velocity amplitude of 70 km/s. It is believed to have formed from the merger of two helium white dwarfs, and to be the progenitor of a helium-rich hot subdwarf. Its remarkable velocity curve consists of a short shocked acceleration followed by near-ballistic deceleration. Optical spectroscopy has recently resolved dynamical structure within the pulsating photosphere.

In contrast, the radius and mass of V652 Her have been measured with a precision seriously limited by sparse low-resolution IUE photometry. To measure the mass to better than +/- 0.1 Msun, constrain the progenitor binary and test the physics of the hydrodynamic pulsation model, a precise measurement of the total flux variation throughout the pulsation cycle is vital.

We propose a series of time-resolved HST/STIS ultraviolet observations. These will measure the effective temperature and angular radius with a phase resolution of 0.025 cycles and precision comparable to the velocities provided by recent optical spectroscopy. The shifted and co-added spectrum will explore the surface abundances of iron-group and heavier elements, and hence address questions of origin and evolution. Unleashing the full power of tomography, the dynamical behaviour of the CIV and SiIV absorption lines, formed at optical depths 100 time smaller than the optical helium lines, will be used to explore how pulsations propagate to the outermost layers of the atmosphere and, possibly, into the wind itself.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR
Scientific Category: Stellar Physics
ID: 14570
Program Title: Understanding the Sequestration of Krypton Atoms in the Interstellar Medium

Principal Investigator: Edward Jenkins

PI Institution: Princeton University

Previous HST observations of UV interstellar absorption features in stellar spectra have revealed that the abundance of free krypton atoms relative to hydrogen in the interstellar medium of the Milky Way is below estimates for the solar abundance ratio of Kr by about 0.3 dex. This seems puzzling in view of the fact that Kr is usually regarded as chemically inert, and its van der Waals binding to neutral partners is extremely weak. In order to identify the most likely mechanism for depleting Kr, a study of Kr I column densities over a large and diverse collection of sight lines may reveal possible relationships of Kr deficiencies with either molecular hydrogen fractions or depletions of other elements by dust formation. The outcome should help to establish the plausibility that free Kr atoms are removed from the gas phase either by the formation of KrH^+ or KrH_3^+, or alternatively, by the trapping of Kr atoms into water ice clathrates on or within dust grains. The objective of this archival research is to retrieve and analyze the STIS E140H and E140M spectra of 79 (or possibly more) stars that have not been studied earlier, in order to measure the column densities of Kr I, Mg II, Mn II, Ge II, and H I. For sight lines with no published values for molecular hydrogen column densities, FUSE spectra will also be downloaded and analyzed.

Proposal Category: GO

Scientific Category: Solar System

ID: 14803

Program Title: COMET NUCLEUS BREAKUP

Principal Investigator: David Jewitt

PI Institution: University of California - Los Angeles

This proposal seeks target of opportunity time to study the next cometary nucleus breakup. The measurement objectives are to determine the dynamics of ejected fragments (both their launch velocities and their non-gravitational accelerations) and to assess the distribution of fragment sizes to the extent allowed by contaminating dust. The science objective is to better understand the breakup mass and mechanism. Most previous measurements of fragmenting comets have suffered from delayed observations having inadequate temporal and spatial resolution. The high resolution, sensitivity and quick response of HST in ToO mode are needed to obtain better data.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Populations

ID: 14571

Program Title: Searching for an intermediate-mass black hole in M 22 with gravitational microlensing

Principal Investigator: Noe Kains

PI Institution: Space Telescope Science Institute

We propose to analyze archival data spanning over 20 years to search for astrometric shifts caused by microlensing of background stars by an intermediate-mass black hole (IMBH) in the core of globular cluster M 22. The detection of such a shift would allow us to make the first unambiguous detection of an IMBH, and to constrain its mass, providing us with valuable insight into the formation of supermassive black holes (SMBH) and galaxy evolution. Non-detections of lensing events, coupled with our simulations, would also allow us to place strong constraints on the presence of an IMBH in M 22, which would be particularly interesting in light of the detection of stellar-mass black holes in this cluster (Strader et al. 2012). The main science product of the archival work, long-baseline astrometric measurements of thousands of cluster and Bulge stars, will also be very useful for stellar population studies, allowing for the study of the rotation of the multiple populations in M 22.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14670

Program Title: Exploring a highly perturbed debris disk associated with an exiled exoplanet

Principal Investigator: Paul Kalas

PI Institution: University of California - Berkeley

We have resolved the debris disk surrounding the 13 Myr-old, F5V star HD 106906 using the Gemini Planet Imager (GPI) and archival coronagraphic data from the ACS/HRC. The GPI H-band images reveal a nearly edge-on torus of dust-scattered light with an evacuated region ~50 AU in radius and a roughly symmetric morphology to ~100 AU (limited by the field of view). The optical ACS/HRC data show a highly asymmetric disk structure from ~250 AU radius (the inner working angle of the data), to ~500 AU radius (a sensitivity limited value). HD 106906 also has an 11 Jupiter mass companion at 650 AU projected separation, and we find that it is misaligned with the debris disk by 21 degrees. The planet may have been dynamically ejected from the system, perturbing the debris disk. We explored the possibility that it has circumplanetary material, finding tentative evidence that HST's optical PSF is extended for HD 106906b compared to 11 other reference stars in the field. However, the HST data are limited such that we cannot confirm the extended PSF structure, and we have no information about the debris disk in the 100-250 AU region where it transitions from a symmetric to an asymmetric morphology, possibly revealing the planet's periastron distance. Here we propose timely STIS coronagraphic observations designed to critically test our finding of extended PSF structure for the exoplanet, and to image the disk structure between 100 and 250 AU radius. These data will have a significant, multi-disciplinary scientific impact on understanding the dynamical co-evolution of planets and debris disks and the nature of circumplanetary material.

Proposal Category: GO

Scientific Category: Stellar Pops

ID: 14734

Program Title: Milky Way Cosmology: Laying the Foundation for Full 6-D Dynamical Mapping of the Nearby Universe

Principal Investigator: Nitya Kallivayalil

PI Institution: The University of Virginia

High-precision astrometry throughout the Milky Way halo is a unique capability of HST, with potential for transformative science, including constraining the nature of dark matter, probing the epoch of reionization, and understanding key physics of galaxy formation. While Gaia will provide unparalleled astrometric precision for bright stars in the inner halo of the Milky Way, HST is the only current mission capable of measuring (1) accurate orbital proper motions for systems at greater distances (> 80 kpc), in order to measure the total mass profile of the Milky Way, or (2) internal kinematics of stars in dwarf galaxies, to test the cusp versus core nature of their inner density profiles. We propose to initiate the next-generation, high-precision, proper-motion survey of all known dwarf galaxies within the Milky Way halo, thus laying the foundation to dynamically map the nearby Universe in full 6-D orbital phase space. Specifically, we propose to use ACS/WFC3 to establish a first-epoch baseline for proper-motion measurements for the 32 known dwarf galaxies within 420 kpc that currently lack sufficient first-epoch imaging. These observations will provide the critical anchor point for forefront scientific results within the next 4 years of HST's life, which can be extended with future missions, including JWST, over 10+ years to obtain unprecedented astrometric accuracy, ensuring that HST leaves a unique and lasting legacy for decades to come.

Proposal Category:	GO
Scientific Category:	Stellar Populations
ID:	14636
Program Title:	TRGB Distances to the Edge Between the Local Sheet and Virgo Infall: Last of the Low Hanging Fruit
Principal Investigator:	Igor Karachentsev
PI Institution:	Russian Academy of Sciences, Special Astrophysical Obs.

There is a gap in an otherwise tremendously successful program with HST to determine the distances and motions of galaxies within 10 Mpc. Nearby galaxies are concentrated to a band stretching toward the Virgo Cluster. Accurate distances from the tip of the red giant branch method have been obtained for a high fraction of nearby galaxies in every direction on the sky EXCEPT in the Local Sheet in the Virgo sector. This region is particularly interesting because it samples the outer extent of the strong influence of the Virgo Cluster: the cluster zero velocity and zero energy surfaces. Details of the velocity field in this region are sensitive to the mass of the cluster out to large radii, information uniquely available because of the proximity of the Virgo Cluster. The existing limited information suggests there is a pronounced velocity shear across the region. Distances can easily be obtained for the targets with single orbit observations.

The observations contribute to an increasingly complete sampling of the resolved stellar populations of nearby galaxies, a compilation of considerable legacy value.

Proposal Category: GO

Scientific Category: Solar System

ID: 14612

Program Title: Titan at Opposite Seasons Using STIS Image Cubes

Principal Investigator: Erich Karkoschka

PI Institution: University of Arizona

This proposal seeks to use STIS with one orbit each in 2017, 2018, and 2019 to map the full disk of Titan at 1024 wavelengths between 530 and 1000 nm and at 0.05 arc-sec sampling in both spatial dimensions. These observations repeat similar STIS observations between 1997 and 2004 in order to create data sets at opposite seasons. The comparison of the old and new data sets will characterize seasonal asymmetries as function of latitude and wavelength. STIS probes many altitude levels from the surface to the stratosphere eight scale heights higher. Radiative transfer models using previous STIS image cubes resulted in a seasonal model of Titan's haze based on the assumption that Titan is symmetric at opposite seasons. This is probably an approximation, and the proposed data are needed to characterize asymmetries. Cassini's mission is too short to observe Titan at opposite seasons. Ground-based adaptive optics systems do not provide a stable point spread function required to create a suitable data cube. HST is the only telescope that can achieve the goal until the next opportunity around 2047. Characterization of seasonal asymmetries provides one of the most sensitive tests for global circulation models. Titan's seasonal cycle is a vibrant current research topic due to 12 years of Cassini data. This proposal will expand STIS data to a range of 22 years. The opportunity is unique, and the required HST time is minimal.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14735

Program Title: Observation of OH in Beta Pictoris exocomets

Principal Investigator: Flavien Kiefer

PI Institution: Tel Aviv University - Wise Observatory

The Beta Pictoris system is a young planetary system embedded in a debris disk that is continually replenished by the collision and evaporation of planetesimals and exocomets. As a result of the edge-on inclination of the debris disk, transiting exocomets can be observed in great detail using absorption spectroscopy. Our previous COS observations yielded the first detection of exocomets in the far-UV, with the discovery of several new exocometary species including HI, CII, NI, OI and several ionization states of Si. Interestingly, the C/O ratio in the exocomets seems to also distinguish the two dynamically different exocomet populations known to exist in the Beta Pictoris system.

Here we propose to search for OH variable absorptions at 3085 Ang. to measure the abundance of water and to identify if water is the key volatile in the exocomets of Beta Pictoris. Positive detections of OH in the exocomets would be the first indirect discovery of water in the Beta Pictoris disk. Moreover, we will investigate the possibility that the two dynamically different exocomet populations have different compositions and origins. These objectives can be achieved by the acquisition of STIS Echelle spectra at different epochs.

Measuring the abundance of OH and the OH/Mg ratio in the Beta Pic evaporating exocomets will enable us to trace the condensation and evaporation processes and their location in the late stages of planetary formation. This will provide valuable insights into the origins of the exocomets of the Beta Pictoris system.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14736

Program Title: Connecting Variability and Metals in White Dwarfs

Principal Investigator: Mukremin Kilic

PI Institution: University of Oklahoma Norman Campus

The Kepler and K2 missions have revealed that about half of the observed white dwarfs with sufficient signal-to-noise ratio light curves have low-level photometric variations at hour to day timescales. Potential explanations for the observed variability include the relativistic beaming effect, ellipsodial variations, eclipses, and reflection off of giant planets in close orbits. However, these are all rare events. Roughly 10% of white dwarfs are magnetic, and magnetic fields can explain part of this puzzle. However, the high incidence (50%) of variability is currently unexplained. HST COS spectroscopy of nearby white dwarfs show that about half of them have metals on their surface. Hence, we propose that the observed variability is due to the rotation of the star coupled with an inhomogeneous surface distribution of accreted metals. We have recently discovered an ideal system to test this hypothesis. J1529 is an apparently non-magnetic white dwarf that shows 5.9% photometric dips in the optical every 38 min. We propose to obtain COS TIME-TAG spectroscopy of J1529 over 4 orbits to search for surface abundance differences throughout the orbit and look for the flux redistribution effect in the optical. These observations will confirm or rule out the idea that inhomogeneous metal accretion on white dwarfs can explain the high incidence of variability. We predict that the LSST will identify ~100,000 variable white dwarfs. Hence, understanding the source of variability in white dwarfs has implications for the current and future transient surveys.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Physics
ID:	14692
Program Title:	Confirming the wide binary companion of IRC+10216

Principal Investigator: Hyosun Kim

PI Institution: Academia Sinica, Institute of Astronomy and Astrophysics

The latest HST optical images of the nearest carbon-rich asymptotic giant branch star IRC+10216 revealed two point-like sources at the center of its circumstellar envelope (CSE). A plausible interpretation is that the dense inner envelope is clearing, and hence revealing the central binary stars and the associated structures. Since IRC+10216 has changed so dramatically in 10 years, more frequent monitoring is necessary. A similar dramatic change is also found in the near-infrared (NIR). The clumps detected over two decades have disappeared in a ground-based observation during Feb. 2016, leaving a single peak in H and K and two peaks in J. The second peak in J has a different color from that of the primary peak and its CSE, implying a different origin and thus supporting the identification as a companion star. In particular, its spectral peak is likely at a wavelength slightly shorter than J band, consistent with an M-type main-sequence star. However, its correspondance with the optical source is not conclusive because of the small field of view of the ground-based NIR observations, traded with the high resolution using the adaptive optics. In order to confirm/refute the identication of the carbon star IRC+10216 and its companion and to monitor the evolution of its CSE, we propose for WFC3 snapshots in two UVIS bands and one IR band to simultaneously achieve (1) high resolution and (2) large field of view for astrometry. This would be the first confirmation of a "main-sequence companion" consisting a "wide binary" with an AGB star, which is the major category of missing companions of evolved stars.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14781

Program Title: Ultraviolet Spectroscopic Monitoring of an ASAS-SN Tidal Disruption Event

Principal Investigator: C. Kochanek

PI Institution: The Ohio State University

Tidal disruption events (TDE), where supermassive black holes destroy stars to produce accretion flares, are of great current observational and theoretical interest. Here we propose a seven epoch STIS UV spectroscopic ``movie'' of a bright, ASAS-SN transient survey TDE spread over the first ~90 days after a rapid TOO trigger. The roughly 15 day cadence is comparable to the expected time scale for kinematic changes and the time scale of observed changes in the optical H and He lines. We will measure the evolution of UV absorption and emission lines from elements (e.g., C, N, Si) and ionization states/potentials not seen in optical spectra of TDEs, which should help to illuminate the dynamical evolution of these fascinating transients. In some cases, the debris from the stellar cores should have significantly enhanced [N/C] abundances due to the CNO cycle, so UV spectra can provide a means of differentiating debris from the core and the envelope of the disrupted star.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14737

Program Title: Unveiling the nature of the only main-sequence pulsar CU Vir

Principal Investigator: Jiri Krticka

PI Institution: Masaryk University

CU Vir is one of the most enigmatic stars of the upper part of the main sequence. It has been the first main sequence star that showed regular radio pulses persisting over decades, resembling the radio lighthouse of pulsars and interpreted as auroral radio emission like planets. The explanation of this effect requires relatively strong stellar wind, which is not predicted theoretically. Moreover, CU Vir, being an unusually fast rotator, belongs to a rare group of magnetic chemically peculiar stars that show rotation period variations caused by torsional oscillations. Last but not least, CU Vir light variability is not yet understood. The HST STIS observations are key to resolve all these problems by studying spectroscopic UV wind and auroral signatures as function of rotational phase. Moreover, these observations will have a broad impact on the physics of stellar and exoplanetary magnetospheres, they will provide insight in the evolution of rotational velocities, and lead to understanding of the light variability of chemically peculiar stars.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14738

Program Title: A Far Ultraviolet Study of Globular Clusters in NGC 3115

Principal Investigator: Arunav Kundu

PI Institution: Eureka Scientific Inc.

The far-ultraviolet (FUV) emission from old stellar systems shows a puzzlingly large factor of 100 variation in the ultraviolet-to-optical flux ratios. This effect is attributed to poorly understood differences between the underlying populations of extreme horizontal branch stars. Globular clusters, which are isolated systems with small internal dispersions in age and iron abundance, offer a promising avenue for understanding the FUV emission in old stellar populations. A far ultraviolet HST study of the giant elliptical galaxy M87 has revealed an extraordinarily UV-bright globular cluster population that is significantly offset from all other globular cluster systems studied to date. We propose an ACS/SBC far-ultraviolet imaging study of the globular clusters in the nearby field S0 galaxy NGC 3115. These observations will fill the gap between the sparse far-ultraviolet studies of globular clusters in mostly local group spirals and M87. It will allow us to test several competing models that link the FUV emission in old stellar populations to Helium enrichment, galaxy environment, binary processes, or metallicity effects and enable us to place the unusually FUV luminous GCs of M87 in context. A better physical understanding of this far-ultraviolet feature in old stellar populations would be an invaluable tool for understanding the evolution of both nearby stellar systems and distant galaxies.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Blackholes

ID: 14693

Program Title: Testing the Torus Origin of the Broad Absorption Line Outflow in WPVS 007

Principal Investigator: Karen Leighly

PI Institution: University of Oklahoma Norman Campus

A significant fraction of quasars exhibits blueshifted broad absorption lines in their rest-UV spectra, indicating powerful outflows emerging from the central engine. These outflows may remove angular momentum, enrich the intergalactic medium, and contribute to feedback in galaxies. Despite years of study, the location and geometry of these outflows is not well constrained. Distance estimates range from the vicinity of the accretion disk to kiloparsecs from the central engine. In addition, global covering fractions are assumed to be significant, but there is little direct support for that assumption.

WPVS 007 is a low-luminosity broad absorption line active galaxy that has shown dramatic variability. A long-term increase in reddening from ~2010 observed by Swift culminated in a 60-day occultation event in 2015. Four HST COS observations, including one during the occultation, found a correlated decrease in the outflow velocity. Leighly et al. (2015) showed that these results imply that both the reddening and the outflow originate in the torus.

A torus origin for BAL outflows is attractive because dust opacity may

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14804

Program Title: Rapid ToO observations of the first gravitational wave counterparts

Principal Investigator: Andrew Levan

PI Institution: The University of Warwick

We propose a series of disruptive ToO observations of the first electromagnetic counterparts to gravitational wave sources. These observations will track the likely rapidly fading counterparts to levels a factor 10 fainter than possible from the ground. They will determine the spectral and temporal evolution, evaluate their power sources, ascertain their contribution to the production of heavy elements in the Universe, pinpoint them on their host galaxies and provide information to hone further searches. In concert with already award late time (>3 week turnaround) observations these observations will provide a unique and powerful view of a newly discovered, but long awaited class of astronomical object.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14805

Program Title: A rapid search for the counterpart to an active magnetar

Principal Investigator: Andrew Levan

PI Institution: The University of Warwick

We propose to obtain a fast response observation of a magnetar undergoing an active period. Utilizing rapid, deep, diffraction limited observations with WFC3 we will maximize the chances of obtaining the IR detection of the magnetar. This in turn yields unique constraints on emission mechanisms, enables the measurement of dynamics (e.g. via proper motion) and can associate the magnetar with a given structure (e.g. young cluster or supernova remnant) in the galaxy. The association with a cluster provides means of measuring the stellar age, in turn informing the stellar properties (e.g. mass) of the magnetar progenitors. We have demonstrated the success of this approach with the detection of the counterpart of SGR 1935+2154 with a magnitude (during bursting activity) of F140W(AB)~25.5, a level extremely challenging to detect variability in from the ground, requiring multiple nights of adaptive optics imaging in typical conditions. Indeed, our observations will be senstive to counterparts significantly fainter than it is possible to detect from any ground based observatory. These observations will allow us to break through the observational barrier that has so far prevented us from detecting counterparts to more than two-thirds of magnetar candidates. With these observations we will construct a fuller picture of magnetars, the routes to their creation, and their role as cosmic engines across the Universe.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Blackholes

ID: 14739

Program Title: Imaging BALQSO outflows: a critical step in assessing AGN feedback

Principal Investigator: Guilin Liu

PI Institution: Virginia Polytechnic Institute and State University

Quasar outflows are increasingly invoked as a major contributor to the formation and evolution of supermassive black holes, their host galaxies, the surrounding IGM, and cluster cooling flows. Using spectral data, our group has determined the distance of the outflows from the central source in a sample of objects. Some of these outflows are found to be at ~10 kpc from the nucleus and thus can be imaged directly using ACS at redshifts 1-3. We therefore propose to obtain the first ever imaging of BALQSO outflows at high redshifts. This project will uncover the spatial geometry of the outflows, which is the final piece needed to derive their kinetic luminosities, and therefore a direct measurement of their importance to AGN feedback processes. We will image each object with filters corresponding to deep absorption troughs. Such configuration will detect light scattered from the same ionic transitions that cause the trough, which are outflowing in directions other than our line of sight. The natural coronagraph supplied by the absorption trough will greatly reduce the flux of the quasar in that narrow spectral region, facilitating the detection of the outflow. To distinguish between the outflow features and the underlying galaxy we will use two narrow band filters at wavelengths of deep troughs as well as a broader band filter that does not cover significant troughs and therefore should show only the underlying galaxy and not the outflowing material.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14637

Program Title: Wide band spectra of nova-like variables: A confrontation of observations with theory

Principal Investigator: Knox Long

PI Institution: Eureka Scientific Inc.

Nova-like variables are the best and nearest examples of steady-state disk accretion onto a compact object. Emission in these system arises from a large number of components, including the WD and secondary star, the accretion disk through which mass is accreted, and a wind through which mass is lost. However, the only wide band ``spectra'' of these variable objects have been constructed by stitching together spectra obtained at different times, and as a result it is difficult to conclude exactly what is causing the departures from the predictions of steady-state accretion disk models that are observed, or to establish the geometry of the wind in these systems. This is a proposal to use HST/STIS to obtain single-epoch, FUV-near IR spectra of five bright nova-like variables, with varying inclinations, to remedy this problem. We will compare this benchmark set of spectra to new models of the disks and winds for this group of cataclysmic variables in order to measure the temperature profiles of the disks, to determine mass loss rates, collimation, and other physical characteristics of the winds, and to assess the overall effect of the dense regions of the wind on the spectral energy distribution.

Proposal Category:	GO
Scientific Category:	Stellar Physics
ID:	14638
Program Title:	What Makes Radio-detected and Optically-detected Supernova Remnants in NGC6946 Different?
Principal Investigator:	Knox Long
PI Institution:	Eureka Scientific Inc.

In the Galaxy, most SNRs were first detected as extended non-thermal radio sources. By contrast, in galaxies beyond the Magellanic Clouds, most SNRs have been identified as emission nebulae with elevated [S II]:Ha emission ratios compared to HII regions. NGC6946, which has had more historical SNe than any other galaxy, is one of the very few galaxies with both a large number of radio and optical SNRs and SNR candidates. Surprisingly, the radio and the optical samples of SNRs in this (and other) galaxies are almost disjoint, possibly due to the fact that the radio-detected objects tend to be located in or very near HII regions with higher than normal extinction. If this is correct, these radio SNRs should be detectable as nebulae with strong [Fe II] emission lines in the near IR, since extinction should be much less of a factor and since the ratio of [Fe II]:Pa Beta is expected to be high, of order 10, in shocked SNR gas, and very low in photoionized regions. To find out, we propose to use existing Pa Beta and new [Fe II] WFC3 imagery of NGC6946, along with the results of our new radio and optical imaging and spectroscopic surveys, to find the radio sample. Since we also should detect many, if not all, of the optically identified SNRs in [Fe II], we will be able to compare the properties (diameter distribution, [Fe II] flux) of the two sub-populations in order to improve our understanding both of the selection effects and of the evolutionary state of the populations. More generally, the combination of radio, optical, IR and X-ray data (from existing Chandra observations) will allow us to complete one of the most detailed characterizations of SNRs in any nearby galaxy.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 14653

Program Title: The most luminous galaxies: strongly lensed SMGs at $1<z<4$

Principal Investigator: James Lowenthal

PI Institution: Smith College

About half of all star formation at high redshift is thought to take place in dust-shrouded starburst galaxies not easily detected in rest-UV surveys. Studying their star formation and gas properties in detail is important but very difficult. We have assembled a new sample of some of the most FIR-luminous galaxies in the Universe and have imaged them in 1.1 mm dust emission and measured their redshifts $1<z<4$ via CO emission lines using the LMT. Our sample of 31 submm galaxies (SMGs) in 28 fields, culled from the Planck and Herschel all-sky surveys, includes 14 of the 21 most luminous galaxies known, with L_FIR>10e14 Lsun and SFR>10e4 Msun/yr. These extreme inferred luminosities -- and multiple / extended 1.1 mm images -- imply that most or all are strongly gravitationally lensed, with typical magnification ~ 10x. About half of the intervening lenses are likely massive galaxy clusters at z~1, with the other half presumably massive galaxies aligned by chance with the SMG. Here we seek deep WFC3/IR images of 22 fields lacking deep HST coverage. Our science goals are (1) to build accurate lensing models, which requires high-resolution images of lensing galaxies and clusters and lensed background galaxies, arcs, and Einstein rings; and (2) to apply the lensing models to any lensed images of the background SMGs themselves to derive structural details of gas and star formation down to scales of 10 to 100 pc, which is needed to understand the fueling and triggering mechanisms of these extreme starbursts. This unique sample of lensed super-starbursts is unlike any previous sample of SMGs and promises new insight into the formation of massive galaxies at early epochs.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14613

Program Title: Searching for the Peak of the Initial Mass Function in Galactic Center Star Clusters

Principal Investigator: Jessica Lu

PI Institution: University of Hawaii

We propose to re-observe the Arches and Quintuplet clusters at the Galactic Center with WFC3-IR to measure the Initial Mass Function (IMF) down to 1 Msun using proper motions with 3x longer baseline and precision. These clusters are ideal targets as they probe one of the most extreme environments in which stellar populations can be spatially resolved and IMFs can be measured accurately. The proposed observations build on our previous two-year proper motion program where we demonstrated the ability to identify cluster members using proper motions down to 2.5 Msun (Hosek et al. 2015). In Clarkson et al. (2012), we used high-precision astrometry in the Arches cluster core to show that the cluster's dynamical mass is too low for a "universal" mass function, indicating that peak of the IMF is likely between 1-2 Msun. The proposed observations extend our cluster sample to 1 Msun, allowing us to directly search for the predicted peak while definitively establishing the high-mass slope of the IMF. The additional epoch of astrometry also makes it possible to measure the velocity dispersion profiles of the clusters, allowing us to constrain their orbits and model the impact of dynamical evolution on their observed mass functions. Ultimately, these observations will result in the deepest and cleanest measurement of the IMF in the Galactic Center environment.

Proposal Category: AR

Scientific Category: ExoPlanets

ID: 14572

Program Title: Photoelectric instability and debris disk rings: One theory to rule them all

Principal Investigator: Wladimir Lyra

PI Institution: California State University - Northridge

HST images of circumstellar debris disks have helped advance tremendously our understanding of these disks, thought to represent planetary systems during the late stages of planet formation as the gas clears and the system becomes optically thin. These systems are analogs of the Kuiper belt in the solar system, and show a variety of non-trivial structures attributed to planetary perturbations and utilized to constrain the properties of the planets. However, analyses of these systems have largely ignored the fact that, increasingly, debris disks are found to contain small quantities of gas. We have recently shown that dust-gas interactions with photoelectric heating can produce some of the key patterns seen in debris disks that were previously attributed to planets. We propose to code software and run a suite of models to develop the theory of photoelectric instability in gas-rich optically thin disks in light of the observational constrains set by HST observations and its interaction with other dynamically important processes such as hydromagnetic turbulence, radiation forces, planetary perturbers, and stellar flares.

Proposal Category: AR

Scientific Category: Blackholes

ID: 14573

Program Title: The Centers of MASSIVE Survey Elliptical Galaxies with Supermassive Black Holes

Principal Investigator: Chung-Pei Ma

PI Institution: University of California - Berkeley

We propose to perform a homogeneous isophotal analysis of all suitable imaging data in the HST Archive for early-type galaxies (ETGs) in the MASSIVE and eMASSIVE samples. MASSIVE is a volume-limited and stellar-mass-selected survey of the structure and dynamics of the 116 most massive ETGs in the northern sky within 108 Mpc. MASSIVE is designed to address a wide range of outstanding problems in ETG formation, including the connection between supermassive black hole (BH) and galaxy growths, the variation in dark matter fraction and stellar IMF within and among ETGs, and the late-time assembly of galaxy outskirts. We have already obtained much of the needed IFS and wide-field imaging for this project; here we propose to add the one missing ingredient - high resolution imaging with HST - to nail down the central profiles. In addition, we will leverage the HST Archive and analyze all available imaging data for eMASSIVE, an extension of MASSIVE to the whole sky and 150 Mpc. We expect a high fraction of the proposed sample of 99 massive ETGs with archival HST data to have flattened central light profiles. We will perform 1-D and 2-D isophotal analysis to measure the core size, radial profile and morphology of each galaxy. We will use the core size and two tight scaling relations to estimate BH mass and sphere of influence, and examine trends in core size, BH mass, and BH-to-bulge mass ratio with galaxy environment. This large sample of ETG imaging data for a well-defined galaxy survey will provide the most comprehensive census of nuclear structure, core size and black hole mass for the most massive galaxies in the local universe.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14639

Program Title: Finding AM CVn stars in 47 Tuc

Principal Investigator: Thomas Maccarone

PI Institution: Texas Tech University

We propose to observe 47 Tuc in He I (using the redshifted H-alpha filter centered on 665 nm) and a relatively broad emission line filter for slightly higher redshift H-alpha at 680 nm to get a clean continuum measurement. These narrow band images will reveal sources in the cluster which are strong in one of the two filters, but not in the other. The objects strong in only H-alpha will be strong candidates for being cataclysmic variables, while the objects strong in only He I will be strong candidates to be ultracompact binaries -- accreting compact objects in which the donor star is a white dwarf. These objects are key tracers of whether globular clusters are important factories for making gravitational wave sources, and Type Ia supernovae. Furthermre, because AM CVn stars are the only class of objects which has a characteristic lifetime shorter than the dynamical evolution timescale of the cluster while also being likely to be numerous, developoing an approach for finding them also opens up the possibility of examining the historical evolution of the cores of globular clusters.

Proposal Category:	AR
Scientific Category:	Stellar Physics
ID:	14574
Program Title:	Unwrapping the Mystery of Flows at the Onset of Common Envelope Using the Remarkable Transient M31 LRN 2015
Principal Investigator:	Morgan MacLeod
PI Institution:	University California, Santa Cruz

The recent red transient M31 LRN 2015 is thought to be caused by a stellar merger. It was discovered in January 2015 and is located in M31. Remarkably, there is imaging of a pre-outburst source in multiple colors in the Hubble Space Telescope (HST) archive. With the color, magnitude, and distance to the source known, we can use these data to link the binary system to the outburst it produced. Our preliminary calculations show that the pre-outburst source is consistent with a 3 to 5 solar mass star evolving up the giant branch (to about 35 solar radii) before it engulfs its companion in a common envelope (CE) episode. This source therefore offers a unique opportunity to place strong observational constraints on the long-uncertain properties of flows at the onset of common envelope interactions. By comparison of the transient to the pre-outburst modeling we find that the transient is dynamical: it takes place in (of order) one binary dynamical time, and the ejecta velocities are above the local escape velocity. Having modeled the pre-outburst stellar properties, we are able to set up hydrodynamic simulations to study the transient. These simulations will determine which evolutionary channels (and which binary mass ratios) produce ejecta velocity, mass, and entropy distributions consistent with the observed transient. This proposal offers the opportunity to unlock the potential of this serendipitous HST detection of the binary system prior to outburst. The proposed detailed modeling effort will maximize the benefit to CE science and our understanding of this long-uncertain phase of binary evolution.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14604

Program Title: Connecting the shape of the FUV spectrum with disk morphology: a combined HST and ALMA study of young stellar objects in Lupus

Principal Investigator: Carlo Manara

PI Institution: European Space Agency - ESTEC

The physical properties of planets reflect the physical and chemical content of the disk in which they form. Direct resolved observations of disks, e.g., with ALMA, provide us with crucial information on the disk properties to verify planet formation theories. ALMA observations have now reached levels of detail that demand as much detail in the modeling. A major input for models to reproduce resolved ALMA observations of gas in disks, the shape and intensity of the FUV radiation impinging on the disk, is still poorly understood. We thus propose to observe the FUV spectrum of three almost unextincted and still accreting young stars surrounded by disks with different morphology, recently studied with our new high-resolution ALMA observations.

Our proposed observations aim at:

1) characterizing the FUV flux of young stars surrounded by disks detected with resolved observations both in dust (0.89mm) and gas (13CO, C18O, and CN) emission with ALMA,

2) studying the chemical properties of their disks to model their gas content, in particular including the FUV flux in the wl<1100 AA region reachable only with HST, which is crucial for H2 and CO photodissociation,

3) determining the relation between the shape of the observed FUV spectrum, in particular the molecular emission lines, with the disk morphology,

4) obtaining simultaneous coverage of the FUV and NUV spectrum to determine the physical origin and shape of the FUV excess above the disk accretion emission.

Finally, the FUV flux determined here will also be a crucial ingredient for disk evolution models, such as photoevaporation models, to test whether they can explain the observed morphology and properties of disks.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14740

Program Title: Exploring a Massive Starburst in the Epoch of Reionization

Principal Investigator: Daniel Marrone

PI Institution: University of Arizona

We request deep multi-band imaging of a unique dusty galaxy in the Epoch of Reionization (EoR), selected via its millimeter-wavelength dust emission in the 2500-square-degree South Pole Telescope survey. Spectroscopically confirmed to lie at z=6.900, this galaxy has a large dust mass and is likely one of the most rapidly star-forming objects in the EoR. Using Gemini-S, we have identified z-band emission from this object that could be UV continuum emission at z=6.9 or from a foreground lens. Interpretation of this object, and a complete understanding of its meaning for the census of star formation in the EoR, requires that we establish the presence or absence of gravitational lensing. The dust mass observed in this source is also unexpectedly large for its era, and measurements of the assembled stellar population, through the UV-continuum slope and rest-frame optical color, will help characterize the stellar mass and dust properties in this very early galaxy, the most spectacular galaxy yet discovered by the SPT.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14754

Program Title: Confronting the 3D Orientation of Galactic Disks in Space: Disk Structure vs. Circumgalactic Gas Flows

Principal Investigator: Crystal Martin

PI Institution: University of California - Santa Barbara

Can the origins of circumgalactic gas flows be recognized by their location relative to galactic disks? Several studies of disk galaxies paired with background quasars (or galaxies) at small angular separation suggest that the physical origin of halo absorption at low impact parameters (< 80 kpc) depends on azimuthal angle, i.e., the angular separation of the sightline from the major axis of the disk. We will use the spiral structure revealed by high-resolution, HST imaging to test the following paradigm: absorption near the galaxy major and minor axes arises, respectively, from gas accretion near the disk plane and winds blown perpendicular to the disk plane. Adopting this framework, we described the kinematics of circumgalactic Mg II absorption and established the required 3D orientation of ten galactic disks. These results, combined with rotation curves, predict the direction in which the spiral pattern in the disk wraps. We propose to resolve the spiral structure in HST images and thereby test the basic assumptions used by many researchers to interpret circumgalactic sightlines. The resulting knowledge will add interpretive value to the growing collection of archived, quasar spectra, which will hopefully elucidate how galaxies get their gas and enrich the surrounding medium with heavy elements.

Proposal Category: SNAP

Scientific Category: Stellar Physics

ID: 14707

Program Title: Searching for the Most Massive Stars in M31 and M33

Principal Investigator: Philip Massey

PI Institution: Lowell Observatory

Our spiral neighbors M31 and M33 can be used as laboratories for testing our theories of massive star evolution. Since massive star evolution depends heavily metallicity, M31 and M33 play a particularly important role in this regard: M31 has a metallicity about 1.5x solar, while M33 possesses a metallicity gradient going from solar in the center to sub-solar in the outer regions. Complete samples of evolved massive stars have been identified in these galaxies, but little is known of their unevolved predecessors, the O-type stars. The upper-left portions of the H-R diagrams of M31 and M33 are virtually empty, not because of the scant numbers of massive stars, but from our lack of knowledge. We are proposing a series of UV SNAPs of the most active star-forming regions in M31 and M33. These regions were previously imaged as part of a Cycle 15 treasury proposal, and have good optical colors, but the UV images were severely affected by charge transfer efficiency issues when the data were taken near the end of WFPC2's life. Our goal is to use photometry from these images to help us identify the most massive stars in these galaxies.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14708

Program Title: Probing the circumgalactic medium of galaxies with deep observations.

Principal Investigator: Smita Mathur

PI Institution: The Ohio State University

The circumgalactic medium (CGM) of galaxies is critical for understanding galaxy formation and evolution, the interplay between feedback and accretion, recycling of metals, and an overall accounting of cosmic baryons. Several large, shallow HST surveys have provided a major step in this direction, finding extended, massive, metal bearing CGMs around star-forming galaxies. High ionization metal lines, such as OVI and NeVIII, are particularly useful to probe the warm-hot gas which is believed to contain most of the baryonic mass. However, these metal lines could be produced in the hot gas in collisional ionization equilibrium, or in cooler photoionized gas. This ambiguity can be resolved by using kinematic information. At the expected temperature of 300,000K, the fraction of neutral hydrogen is small, but detectable and the Lyman alpha line is thermally broadened to about 75 km/s. Thus Broad Lyman Alpha (BLA) lines provide a useful tool to probe the hot gas, but detecting BLAs require high S/N spectra. We propose high S/N COS G160M observations of a carefully selected target to detect BLAs from CGMs of two galaxies to better understand the physics of the CGM. With the proposed deep observations we will directly measure the temperature, metallicity and mass of the warm-hot gas, providing valuable input to models of galaxy formation. Such deep observations are crucial to understand the results from shallow surveys that have used hundreds of HST orbits, but the investment of time is still modest.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14614

Program Title: Death or Survival? Determining the nature of SNe IIn-P explosions

Principal Investigator: Jon Mauerhan

PI Institution: University of California - Berkeley

An increasing number of transients classifiable as interacting supernovae of Type IIn have become the subject of intense debate, as the death or survival of the precursor star is unclear. This is because giant non-terminal eruptions from massive luminous blue variable (LBV) stars can spectroscopically resemble SNe IIn and achieve comparable luminosities via shock interaction with pre-existing circumstellar material (CSM). The stellar origin of the new SNe IIn-P class of explosions is particularly controversial. Competing interpretations predict stellar progenitors with very different initial masses and explosion outcomes: 1) non-terminal super-Eddington eruptions from LBVs; 2) collapsars from very massive stars that should die within their natal OB associations; and 3) electron-capture SNe from super-AGB stars with dense CSM envelopes. To resolve the uncertain origin of SNe IIn-P, we propose a simple and inexpensive optical imaging experiment to see if there is a luminous surviving star remaining at the site. UV imaging is also proposed to determine the nature of a UV source detected in pre-explosion GALEX images, and to survey the progenitor's environment for sibling O-type stars.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Stellar Populations

ID: 14762

Program Title: A UV census of the sites of core-collapse supernovae

Principal Investigator: Justyn Maund

PI Institution: University of Sheffield

Core-collapse supernovae (CCSNe) occur in star-forming galaxies. The locations of CCSNe are inextricably tied to where the progenitors were formed and the massive stars that formed along side them. The nature of the host stellar population at the sites of SNe provides a record of the origin of the SN progenitors and tells us of the role SNe play in the physical evolution of their host environments.

We propose a SNAP imaging program, that exploits the unique capability of HST to conduct high-resolution UV imaging, to image the luminous, UV bright massive star populations at the sites of H-poor Type IIb and Ibc SNe. The aim of this program is to assess the star formation history at the sites of these SNe (through properties such as the number of massive stars in the SN environments, their spatial extent, their age and total mass) to understand the origins and subsequent explosion properties of these events.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14763

Program Title: Exploring the source of the late-time brightness of SN 2011dh

Principal Investigator: Justyn Maund

PI Institution: University of Sheffield

Late-time HST broad-band photometric observations of SN 2011dh in 2014 and 2016 have shown that, rather than continuing to decline in brightness, the light curve is flattening off. The reason for this is unknown, but could be due to "freeze-out" in the ejecta, the onset of interaction between the ejecta and a new dense circumstellar medium, the presence of a light echo or, even, the presence of a binary companion being slowly revealed. Scenarios involving the onset of interaction between the ejecta and a distant circumstellar medium and the presence of a light echo in a dust shell around the SN, all depend directly on the mass loss history of the Yellow Supergiant progenitor. We propose a series of broad and narrow band observations of SN 2011dh to test each of the possible scenarios, and place constraints on the current properties of the ejecta of this SN and the mass loss history of the star that exploded. Only HST is capable of providing the combination of spatial resolution and depth at UV and optical wavelengths that will be critical to making precise photometric measurements of SN 2011dh.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14709

Program Title: HST/WFC3 Spectroscopy of < 400 AU Companions to Orion Young Stellar Objects

Principal Investigator: Brian Mazur

PI Institution: University of Toledo

We propose WFC3 G141 grism spectroscopy of companions to young stellar objects (YSOs) in the Orion molecular cloud which were identified in a WFC3/HST 1.6 micron survey of 320 YSOs in Orion. We will target six close companions with separaitons < 400 AU which have F160W magnitudes between 17-19; these are too faint obtain spectra from ground-based telecopes using LGS AO. To determine spectral types and masses for these sources, we will use grism spectroscopy to detect broad water features in the photospheric spectrum. These observations are part of a coordinated spectroscopy campaign; the remaining companions have been/will be observed using spectrographs on ground-based telescopes as well as a HST (Cyde 22). These data will constrain the companion mass function at projected separations of 100-1000 AU from Orion young stellar objects. Given their faint magnitudes, as many as half of the companions may be below the Hydrogen burning limit. With spectra, we can determine whether or not there is an excess of sub-stellar companions relative to the field IMF at these separations; thereby testing whether the companions form from the fragmentation of the parental cloud or by fragmenation in protostellar disks. Furthermore, the HST survey showed that the observed fraction of stars with companions increases ~50% between low and high stellar density region in Orion; suggesting that the formation of multiple systems is dependent on the birth environment. With spectra, we can explore the physical mechanisms for this enhanced formation.

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14694

Program Title: SDSSCGB-46589.1 -- a Lyman Alpha Blob at Low Redshift?

Principal Investigator: Stephan McCandliss

PI Institution: The Johns Hopkins University

We present observations that suggest SDSSCGB-46589.1 may be a Lyman alpha blob at a redshift of z = 0.273. Lyman alpha blobs are typically found in abundance at redshift around 2 - 3, in strongly clustered environments. They are curious markers of large scale structure, devoid of continuum emission, with luminoities L(Lya) ~ 1e44 erg/s, and linear dimensions ~ 100 kpc. The exact mechanism(s) for excitation have not been conclusively identified, but several have been proposed, including excitation from cold accretion streams, resonance scattering from nearby sources, supernovae or stellar driven outflows, etc. They are anticipated to be rare at low redshift, with the nearest one ever found residing at z =1. If confirmed by the observations proposed here, then this would be the lowest redshift Lyman alpha blob ever found. It would then offer the opportunity to fully examine its location within the cluster environment, wherein high spatial and spectral resolution observations could be brought-to-bear, with the ultimate goal of determining the excitation mechanism for these enigmatic objects. Our goal for this proposal is to search for embedded continuum emitting sources, and to confirm or deny the Lyman alpha blob nature of this object through the use of far-UV imaging and slitless spectroscopy.

Proposal Category: AR

Scientific Category: IGM and COS

ID: 14575

Program Title: A Flexible Cosmic Ultraviolet Background Model

Principal Investigator: Matthew McQuinn

PI Institution: University of Washington

HST studies of the IGM, of the CGM, and of reionization-era galaxies are all aided by ionizing background models, which are a critical input in modeling the ionization state of diffuse, ~10^4 K gas. The ionization state in turn enables the determination of densities and sizes of absorbing clouds and, when applied to the Ly-a forest, the global ionizing emissivity of sources. Unfortunately, studies that use these background models have no way of gauging the amount of uncertainty in the adopted model other than to recompute their results using previous background models with outdated observational inputs. As of yet there has been no systematic study of uncertainties in the background model and there unfortunately is no publicly available ultraviolet background code. A public code would enable users to update the calculation with the latest observational constraints, and it would allow users to experiment with varying the background model's assumptions regarding emissions and absorptions. We propose to develop a publicly available ionizing background code and, as an initial application, quantify the level of uncertainty in the ionizing background spectrum across cosmic time. As the background model improves, so does our understanding of (1) the sources that dominate ionizing emissions across cosmic time and (2) the properties of diffuse gas in the circumgalactic medium, the WHIM, and the Ly-a forest. HST is the primary telescope for studying both the highest redshift galaxies and low-redshift diffuse gas. The proposed program would benefit HST studies of the Universe at z~0 all the way up to z = 10, including of high-z galaxies observed in the HST Frontier Fields.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14695

Program Title: WFC3 Imaging of 24 um Dropout Protostars in Orion

Principal Investigator: S. Megeath

PI Institution: University of Toledo

We propose WFC3 imaging of four unusual candidate protostars that were uncovered in Spitzer and Herschel observations of the Orion Molecular Cloud. These sources exhibited a combination of weak 24 um fluxes, modest to bright 70 um fluxes, low luminosities and bolometric temperatures, but comparatively bright emission between 3.6 and 8 um. Since they did not fall into one of the typical protostar classes, they were not targeted for futher study. A recent HST/WFC3 F160W snapshot survey serendiptiously imaged one of these sources, revealing a bipolar nebula with a broad dust lane and binary point sources. This suggest that the lack of 24 um emission might be due to dust clearing in the inner disk and envelope by the binary. We propose to image the remaining four other sources with WFC3 in the F160W band, all of which have been detected in lower resolution, ground-based H-band observations and three of which show some sign of extension in the H or Ks-band. F160W imaging is essential to understand the geometry and inclination of the envelope and interpret the SEDs. These data will place these objects into the context of our picture of protostellar evolution, and test the possibility that these are envelopes being cleared by the gravitational torques from binary systems.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14764

Program Title: Measuring the structure of Fomalhaut's dusty debris belt via a fortuitous stellar occultation

Principal Investigator: Tiffany Meshkat

PI Institution: California Institute of Technology

Fomalhaut, a young nearby A4V star, is surrounded by an inclined dust debris belt, directly imaged in optical scattered light with HST. The proper motion and parallax of Fomalhaut will move this belt across an 18.5 magnitude background star in the next decade. This presents a unique and fortuitous opportunity to probe the dust structure and confirm disk dynamical theory to unprecedented resolution. In Cycle-21 we obtained HST/STIS spectra of the background star during the diffuse phase of the debris disk occultation. We propose obtaining HST/STIS spectra during the thick (Cycle-24 to 26), and pristine (~2021 with JWST) phases of occultation as the debris disk moves across the target background star. This is a rare opportunity to measure - for the first time - the dust optical depth structure in a known planet-forming system, providing a valuable constraint on current planet formation theories. This experiment will act as a pathfinder for this type of science for future observations with JWST and future ELTs.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14671

Program Title: An HST proper-motion and spectral study of the optical jet in 4C +00.58

Principal Investigator: Eileen Meyer

PI Institution: University of Maryland Baltimore County

We have recently discovered a remarkably detailed optical jet in the nearby radio galaxy 4C 00.58, which we consider a 'moderate power' hybrid-source analog to the archetypal jets M87 and 3C 273. The unusual 'X-shaped' large-scale radio morphology of this source is thought to be the result of a recent merger-induced reorientation, and the jet displays a remarkable series of 'cannonball' ejections clearly detected in radio through X-rays. The clarity of the optical features and nearness of the source make it an ideal target for a prospective HST proper-motions study. Previous HST proper-motion studies which revealed superluminal motions in M87 and 3C 264 relied on archival WFPC2 observations and long observing baselines. With the high astrometric precision possible with an all-ACS/WFC imaging study, we can reach 0.5c accuracy with a time baseline of 4 years, requiring only a single additional orbit in cycles 24 and 26, in combination with our existing ACS/WFC imaging from 2015. We also request complimentary near-UV observations (WFC3/UVIS F225W) in order to map the spectral evolution of the knots and hotspot and allow better constraints on the emission mechanisms and physical parameters in the jet.

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14654

Program Title: A Second Ladder: Testing for Bias in the Type Ia Distance Scale with SBF

Principal Investigator: Peter Milne

PI Institution: University of Arizona

We propose obtaining Surface Brightness Fluctuation (SBF) distances to the hosts galaxies of 20 nearby type Ia supernovae (SNe Ia), resulting in a sample of 29 SNe Ia in 27 galaxies when combined with HST-SBF distances from the literature. This sample can then be compared with the existing 18 SN Ia distances from Cepheids. Through these comparisons, we will determine if there are any discrepancies between the SBF distance scale, which is extended into the Hubble flow using early-type galaxies, and the SNIa distance scale, for which local calibrators are scarce and host galaxy types and SN environments are heterogenous. Since recent measurements of UV-optical colors suggest that SN Ia properties do depend on galaxy type and environment, it is essential that SNe Ia in all galaxy types are included when extending SN Ia distances to the distant Hubble flow. Since the conclusion that universal expansion is accelerating was originally based on SNe Ia distances, and because recent measurements of UV-optical colors suggest that SN Ia properties do depend on galaxy type and environment, it is essential to measure the same types of SNe in the same types of galaxies. To meet this goal, we propose to measure high-precision SBF distances to all early-type galaxies that have hosted SNIa within 80 Mpc. We will therefore be able to distinguish between systematic offsets in the derived Hubble constant between galaxies and/or SNe of different types and correct for them. SBF is the only distance measurement technique with statistical uncertainties comparable to SN Ia that can be applied to the early-type of galaxies in which the majority of the high-redshift SNIa occur.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14710

Program Title: Multiple Stellar Populations in Young Magellanic Cloud Clusters

Principal Investigator: Antonino Milone

PI Institution: Australian National University

The finding that most intermediate-age (~1-2 Gyr old) star clusters in both Magellanic Clouds (MCs) exhibit an extended main-sequence turn off (eMSTO) has been one of the most-intriguing discoveries made by HST in the field of stellar astrophysics. A huge effort has been undertaken to understand the eMSTO but the physical mechanism that is responsible for the eMSTO is still unknown. Several authors have suggested that the eMSTO is due to an age spread of ~100-500 Myr and that the intermediate-age MC clusters are the young counterparts of the old Galactic globular clusters (GCs) with multiple populations. This scenario would imply that the eMSTO is present in massive GCs only. As an alternative, the eMSTO could be due to coeval stellar populations with different rotation rates. In that case the eMSTO should be unrelated to the mass of the host GC.
Our recent discovery that three ~1-300 Myr-old LMC clusters exhibit not only an eMSTO but also a split MS may provide a new angle to investigate the multiple-population phenomenon. We propose to observe 9 GCs in the LMC and the SMC with ages between ~20 and ~600 Myr and masses between ~3,000 and 50,000 solar masses. This interval of masses and ages is almost unexplored to date. We plan to obtain deep imaging in the F336W and F814W bands. These are very efficient filters to search for eMSTOs and split MSs and to constrain the internal variation of age and/or the rotation rates of the distinct populations. Moreover, we will use the F656N filter to detect any H-alpha emission either due to pre-MS stars or fast-rotating Be-stars. We will thus understand to what extent age, rotation, and GC mass are responsible for the eMSTO.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Solar System

ID: 14576

Program Title: Variability of Jupiter's main auroral emission and satellite footprints

Principal Investigator: Luke Moore

PI Institution: Boston University

Jupiter's UV auroral emissions are the brightest in the solar system. They include the main auroral emission, which is associated with a system of corotation enforcement currents, and patches of bright emission called the satellite footprints because they occur at the ionospheric end of field lines linked to Jupiter's moons Io, Europa, and Ganymede. Because the footprints' ionospheric positions are linked to a fixed radial distance in the magnetosphere, changes in the satellite footprint locations are likely due to changes in Jupiter's magnetospheric field configuration. Variability in the main emission location is more complicated by comparison because the main emission can be influenced both by the field configuration and by other factors related to the corotation enforcement current system. We propose to analyze HST images of Jupiter's UV aurora to quantify variability in the satellite footprint locations and main emission. Comparing the variability of these two features will establish the cause of shifts observed in Jupiter's main emission and will provide valuable constraints for models of Jovian magnetosphere-ionosphere coupling. This work is timely because it will provide a framework for the upcoming Juno mission, which will study Jupiter's polar regions. Our work builds upon previous studies of auroral variability but will be the first to focus on images from the Galileo era and make direct comparisons to magnetospheric variability observed in situ. This proposal supports the HST UV initiative and the proposed analysis was not included in the original GO proposals.

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14655

Program Title: Probing Warm-Hot Gas in the Outskirts of Galaxy Clusters Using Quasar Absorption Lines

Principal Investigator: Sowgat Muzahid

PI Institution: The Pennsylvania State University

By cross-correlating the recently published sample of clusters by Bleem+15 from the 2500 deg^2 South Pole Telescope Sunyaev-Zel'dovich effect survey and the sample of all-sky UV-bright QSOs by Monroe+16, we have constructed a sample of 9 QSO-cluster pairs in the redshift range 0.1<z<0.7. In all cases the QSOs are in the background and at impact parameters of r ~(1-5)r_500 (r_500 being the radius within which the mean matter density is 500 times the critical density of the universe). This sample gives us a unique opportunity to probe unexplored cluster outskirts. Here we propose to obtain 3 QSO spectra as a pilot program that will probe the warm-hot gas, with log (T/K) = 5-6, via the OVI and NeVIII absorption lines, in the outskirts of 3 clusters at z~0.46.

Recent cosmological hydrodynamical simulations suggest that the outskirts of galaxy clusters beyond r >r_500 are ``cosmic melting pots", where galaxies and groups of galaxies are stripped of their metal-rich gas by tidal forces and ram pressure provided by the cluster atmosphere. This enriches the ICM with heavy elements and dissipates heat, thus establishing the overall thermodynamical and chemical structures of galaxy clusters. These simulations predict that the warm-hot gas atmosphere extends out to the accretion shock located at r ~(4-5)r_500, and that it is too cool to be probed via X-ray emission. Detecting this warm-hot gas in the outskirts of galaxy clusters will not only help account for some of the ``missing baryons", but it will also advance our understanding of the physics of galaxy clusters and their use as cosmological and astrophysical laboratories.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14741

Program Title: MY Cam: can homogeneous evolution produce gravitational-wave progenitors?

Principal Investigator: Ignacio Negueruela

PI Institution: Universidad de Alicante, Dpto de Fisica

Besides opening the era of gravitational-wave astrophysics, GW150914 has revolutionized the field of massive stars. GW150914 proves the existence of stellar-mass black holes in a configuration that current models for stellar evolution can only reproduce in special conditions of homogeneous evolution and/or low metallicity.

Only a handful of very-massive binaries that could lead to a binary black hole are known. We request UV spectroscopy of MY Cam (38Msun+32Msun), the best laboratory to test several predictions by current models, in order to derive stellar abundances and wind parameters that are inaccessible from the ground. Together with our previous photometric and spectroscopic exhaustive coverage, the STIS spectra will be key to characterize the pre-common envelope phase and test the homogeneous evolution hypothesis, critical ingredients of the different progenitor scenarios proposed to explain GW15091

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14615

Program Title: The Evaporating Exosphere of a Young Planet

Principal Investigator: Elisabeth Newton

PI Institution: Harvard University

Young planetary systems offer the opportunity to study the early stages of planetary and atmospheric evolution. Exoplanets in young stellar clusters, which have known ages, provide a valuable benchmark for models of these processes. K2-25b is a Neptune-sized exoplanet recently found to transit a mid M dwarf member of the Hyades open cluster (625 Myr from isochrone fitting). Atmospheric escape is thought to play an important role in sculpting the final compositions of low-mass planets like K2-25b. At 3.7 Earth-radii, K2 -25b may represent the puffy precursor to the close-in super-Earths and mini-Neptunes found around older mid M dwarfs. This star's youth, proximity and high levels of activity offer a unique opportunity to study atmospheric evaporation. We propose to observe two transits of K2-25b at Lyman alpha wavelengths in order to determine the size of the planetary exosphere. We have simulated the expected Lyman alpha spectrum of this star using representative a stellar profile and interstellar absorption, and considered the intrinsic stellar variability. We estimate that we will obain a S/N of 14.7 in the integrated flux in the blue wing of the Lyman alpha line, where the transit signal is expected. A 50% Lyman alpha transit depth was recently observed for Gl 436b, which is a Neptune-sized planet in orbit around an old, inactive M dwarf. Our observations will result in a 10.6 sigma detection of the planetary exosphere if the transit is the same depth as for Gl 436b.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14742

Program Title: Improving Central Black Hole Mass Measurements in Low Mass Early Type Galaxies

Principal Investigator: Dieu Nguyen

PI Institution: University of Utah

Measurements of black hole masses in massive early type galaxies have revealed that they tightly correlate with the properties of their host galaxies. At lower galaxy masses, almost no black hole mass measurements exist in early type galaxies, while existing measurements in later type galaxies show significant scatter. By finding and measuring the mass of black holes in low mass early type galaxies we can (1) constrain the fraction of low mass galaxies with black holes, an important measurement for understanding the formation of the first seed black holes, and (2) anchor the black hole mass scaling relations and quantify the scatter in these relations.

We propose to make a robust dynamical estimation of the central black hole masses in three nearby, low mass early type galaxies. We request HST/STIS spectroscopy to constrain the variation in the stellar populations and mass-to-light ratio at high spatial resolution. We will combine this information with new and archival HST imaging to create accurate stellar mass maps of each galaxy. These will be combined with existing stellar kinematic maps from adaptive optics Gemini/NIFS and VLT/SINFONI data. The resulting analysis will enable us to dynamically measure black hole masses below the mass of any known central black holes.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14743

Program Title: Determining the explosion mechanism of a superluminous supernova through the deepest ever late-time study

Principal Investigator: Matt Nicholl

PI Institution: Harvard University

The superluminous supernova (SLSN) SN 2015bn is one of the three nearest objects of its kind to date, and is now the best studied. However, despite a wealth of observations within ~1 year of peak light, the explosion mechanism remains elusive. Here we propose to distinguish between the popular scenarios of magnetar spin-down, circumstellar interaction and pair-instability explosion, by obtaining the latest and deepest ever images of a SLSN at around 2 years after explosion. At this phase, competing models predict robust colour differences, which we can detect in 3 orbits of HST+ACS observations (with 3 more orbits in the following cycle required for host galaxy template subtraction, also leading to a detailed host analysis). In the decade or so since the first SLSNe were discovered, no event has had the combination of late-time luminosity, proximity and a sufficiently faint host to be able to follow to such a late phase. We stress that these observations are new, timely, and only possible for ~1 SLSN per decade. Furthermore, we have a robust magnitude prediction based on extensive data, and the colour test we wish to perform is powerful yet relatively straightforward, and only possible using HST.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 14806

Program Title: SAFE: Star clusters, lyman Alpha and Feedback in Eso338-04

Principal Investigator: Goeran Oestlin

PI Institution: Stockholm University

The Lyman alpha line is a widely used probe of the distant universe. However, being a resonant line it is prone to scattering on neutral hydrogen. Hence the radiative transport through galaxies sensitively depends on the structure, kinematics and dust content of the ISM, which in turn are strongly affected by feedback from massive star formation. Imaging observations have demonstrated that Lyman alpha emission from galaxies is dominated by a large scale diffuse component. Here we propose a multi aperture COS study of, ESO338-04, the nearest and brightest Lyman alpha galaxy. From this, we will deduce the Lyman alpha profile - in which the scattering history is imprinted - and how it varies across the galaxy, and for the first time probe the dominant diffuse component. Low ionisation metallic absorption lines will be used to study the neutral ISM kinematics along several sight lines and determine the outflow geometry. We will add two STIS slits from which we will study the Lyman alpha and H-beta profile on top of the brightest clusters at superb spatial and spectral resolution.

The result will be the first spatially resolved study combining neutral ISM kinematics and Lyman alpha profiles in a galaxy, from which we will build a realistic model of that accounts for the Lyman alpha emission from the entire galaxy. The data and results will have a strong legacy in the JWST and ELT era for interpreting Lyman alpha spectroscopy of high redshift sources when the UV window offered by HST has closed.

Proposal Category: AR

Scientific Category: IGM and COS

ID: 14577

Program Title: Resolution and Physics Beyond Simulations: New Multi-Phase Models of the Circumgalactic Medium

Principal Investigator: Benjamin Oppenheimer

PI Institution: University of Colorado at Boulder

Today's highest resolution cosmologically-based hydrodynamic simulations fail to resolve the fragmentation scale of cool clouds condensing out of a hot, ambient halo. These clouds are likely responsible for the majority of quasar absorption lines observed in the CGM by the COS on Hubble. We propose to develop a completely new cloud model following the condensation, propagation, and destruction of clouds surrounded by a hot halo medium. Our unique model resolves physics far below the scales of zoom hydro simulations, while its flexible and statistical implementation allows a rapid parameter exploration not possible using high-resolution idealized simulations. Three features separate our exploration of CGM physics from similar studies: 1) using robust inputs from state-of-the-art zoom simulations that reproduce key CGM observations and constrain the radial profiles of density, metallicity, and temperature, 2) using the latest cooling and ionization tables that account for non-equilibrium effects in the presence of an ionizing background, and 3) generation of mock spectra for direct comparison with the rich datasets available from COS observations. We will concentrate on the physics regulating cloud formation, transport, and dissipation under the influence of a hot, ambient halo medium in halos ranging from Milky Way to cluster scales. A central question we hope to answer is why passive, red galaxies appear to have as much cool CGM gas as active, star-forming galaxies. We will also model cloud velocities, absorption line widths, and the implications for High Velocity Clouds. We will publicly release our code to the community for wider use.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14656

Program Title: How does ionizing radiation escape from galaxies?

Principal Investigator: Ivana Orlitova

PI Institution: Astronomical Institute, Academy of Sciences of CR

Search for sources that reionized the Universe from z~15 to z~6 is one of the main drivers of present-day astronomy. Low-mass star-forming galaxies are the most favoured sources of ionizing photons, but the searches of escaping Lyman continuum (LyC) have not been extremely successful. Our team has recently detected prominent LyC escape from five Green Pea galaxies at redshift ~0.3, using the HST/COS spectrograph, which represents a significant breakthrough. We propose here to study the LyC escape of the strongest among these leakers, J1152, with spatial resolution. From the comparison of the ionizing and non-ionizing radiation maps, and surface brightness profiles, we will infer the major mode in which LyC is escaping: from the strongest starburst, from the galaxy edge, through a hole along our line-of-sight, through clumpy medium, or directly from all the production sites due to highly ionized medium in the entire galaxy. In parallel, we will test the predictive power of two highly debated indirect indicators of LyC leakage: the [OIII]5007/[OII] 3727 ratio, and Lyman-alpha. We predict that their spatial distribution should closely follow that of the ionizing continuum if column densities of the neutral gas are low. This combined study, which relies on the HST unique capabilities, will bring crucial information on the structure of the leaking galaxies, provide constraints for hydrodynamic simulations, and will lead to efficient future searches for LyC leakers across a large range of redshifts.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14657

Program Title: The wind variability in oscillating massive stars

Principal Investigator: Lida Oskinova

PI Institution: Universitat Potsdam

The majority of massive stars have the spectral type B and pulsate. Their interiors and photospheres have been extensively studied over decades by means of high-precision photometry and spectroscopy in the optical. However, very little is known about the physics of their stellar winds, and in particular about the connections between stellar pulsations and winds. We propose to close this gap and obtain monitoring of important UV lines formed in wind of two representative massive stars over their pulsation period.

This proposal takes advantage of the unique capabilities of HST/STIS for UV spectroscopy. We focus on two well studied beta Cephei variables that have similar stellar parameters, but different magnetic field strengths and pulsational behavior. From spectral monitoring of beta CMa and xi1 CMa we will study how wind ionization, mass flux, and wind velocity change over the stellar pulsation cycle. We already secured complementary observations in X-ray and optical. Unexpectedly, we discovered that one target, xi1 CMa, pulsates in X-rays in phase with the optical oscillations.

Our state-of-the-art non-LTE expanding stellar atmospheres and 3-D stellar wind simulations will allow thorough exploitation of the STIS spectra. As a result, we will empirically establish how changes in stellar effective temperature and radius lead to the changes in the stellar wind properties. This will provide new and important insights for the theoretical understanding of stellar wind driving in massive stars.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14744

Program Title: A Definitive UV-Optical Template for Iron Emission in Active Galactic Nuclei

Principal Investigator: Daeseong Park

PI Institution: Korea Astronomy and Space Science Institute (KASI)

The spectra of broad-line AGNs typically show strong blends of Fe II emission that form a pseudo-continuum covering much of the UV/optical range. However, the complex Fe II emission is difficult to model theoretically, and current models still struggle to match the details and diversity of observed Fe II emission in quasars. Accurate measurements of the emission lines and continuum in quasar spectra require the use of empirically derived iron templates based on observations of narrow-line Seyfert 1 galaxies. Fitting Fe II emission and separating it from the Balmer lines and Mg II is required for deriving accurate virial black hole masses in quasars, for investigating broad-line region structure and dynamics via reverberation mapping, and for probing quasar metal enrichment over cosmic time. The existing templates, however, suffer from low S/N and non-contemporaneous data with limited wavelength coverage, which consequently limits the accuracy of almost all spectroscopic measurements of continuum and emission lines in AGNs. Thus, it is critically important to derive a new empirical iron template having high S/N and complete UV/optical coverage simultaneously observed with a consistent aperture. To achieve this goal, we propose to obtain new STIS spectra covering 1150 -10270 A for a new and better identified Fe II template galaxy, Mrk 493, which will yield the first consistent and complete UV/optical iron template. Our new Fe II template will provide the best practical tool to enable accurate modeling and fitting of the iron emission blends in AGN spectra, thus improving the understanding of black hole masses, broad-line region physics, and the cosmic evolution of AGNs.

Proposal Category: GO
Scientific Category: Galaxies
ID: 14658
Program Title: Massive Star Clusters and the Origin of Ultra-Diffuse Galaxies

Principal Investigator: Eric Peng

PI Institution: Peking University

Observations of nearby galaxy clusters at low surface brightness have identified galaxies with low luminosities, but sizes as large as the Milky Way. These so-called ``ultra-diffuse galaxies'' (UDGs) mange to survive in dense environments like the Coma cluster despite having very low stellar mass densities, suggesting that they may be extremely dark matter-dominated. While some have suggested that they are ``failed L* galaxies'', others contend that UDGs are consistent with the high spin tail of the dwarf galaxy halo angular momentum distribution. The recent discovery of globular clusters (GCs) in three UDGs has shed light on the nature of UDGs, but also raised new questions. Total mass estimates inferred from GC numbers and kinematics show that these galaxies have very high mass-to-light ratios (M/L>1000), and point to very inefficient star formation. The existence of GCs, however, requires that these galaxies must have at one point had an intense and efficient starburst. This conundrum is amplified by the presence of a nuclear star cluster in two UDGs, but not in others. Further investigating the stellar populations of UDGs, e.g., through integrated spectroscopy, is challenging due to their low surface brightness. Observing their star cluster populations with HST, however, is comparatively easy, and provides key information on the total masses and star formation histories of these newly identified class of galaxy. We propose to use ACS/WFC and WFC3/UVIS to survey 36 Coma cluster UDGs for globular and nuclear star clusters. Our program will be the first systematic search for star clusters in a large sample of ultra-diffuse galaxies.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14696

Program Title: The Physics of the Jets of Powerful Radio Galaxies and Quasars

Principal Investigator: Eric Perlman

PI Institution: Florida Institute of Technology

We propose HST polarimetry of the jet of PKS 0637-752. This object represents the quasar jet with the most extreme SED, thought to be the most Compton dominated of all, and now that the IC/CMB model appears to be ruled out (thanks in large part to our discovery of high optical polarization in the knots of the PKS 1136-135 jet), it provides an excellent opportunity to test the applicability of synchrotron models for jet X-ray emission in even the most extreme circumstances. While the synchrotron model does not have the extreme requirements of exceptionally fast flows (Gamma>30) at hundreds of kpc, tiny viewing angle (only a few degrees) and super-Eddington kinetic power, it does require particles to be accelerated up to at least tens of TeV and hence radiative lifetimes as short as a few years.

Polarization is a critical parameter for understanding jet flows, and only HST has the resolution and capability to perform this measurement. The data will confirm which mechanisms are operating to create its optical and X-ray emission, and will show locations where the magnetic fields are being structured by shocks and shears. Comparison with in-hand radio polarimetry at matched resolution will untangle whether the optical and radio emitting particle populations occupy the same or different volumes, as in lower power jets where this was discovered using our earlier HST polarimetry. Additional Chandra observations will also look for spectral curvature and possible variability in the X-rays, which could give us additional information about the high-energy synchrotron component.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14697

Program Title: A Cepheid Distance to NGC 4051

Principal Investigator: Bradley Peterson

PI Institution: The Ohio State University

We propose to measure an accurate Cepheid-based distance to the narrow-line Seyfert 1 (NLS1) galaxy NGC 4051, the nearest and one of the best-studied objects in its class. Distances quoted in recent literature range from 9 to 18 Mpc. A precision distance is necessary in order to understand the gas flow energetics to better than a factor of four, and indeed to determine whether the accretion rate is typical of other NLS1s (if at the maximum distance currently assumed) or simply typical of normal Seyfert 1 galaxies (if at the minimum distance). A precision distance is also required to effect a direct comparison of (distance-dependent) stellar and gas dynamical measurements of the central black hole mass with that measured by (distance-independent) reverberation mapping. NGC 4051 is one of fewer than 10 nearby reverberation-mapped AGNs, and the only one classified as an NLS1, for which such black hole mass comparisons currently are possible, and for which there is no other path to a precise distance.

Proposal Category:	GO
Scientific Category:	Stellar Physics
ID:	14672
Program Title:	Tracing the Earliest Nucleosynthesis from Elements Just Past the Iron Peak in Extremely Metal-Poor Dwarfs
Principal Investigator:	Ruth Peterson
PI Institution:	SETI Institute

The assembly sequence of our Galactic halo is encoded in spectra of its surviving low-metallicity turnoff stars. While the investigation of the heaviest elements (Z > 55) reveals they were produced in two independent time scales by rapid- and slow neutron capture (r- and s-process), the light trans-ironic elements with atomic number Z from 32 to 52 show striking abundance patterns that are open to a range of interpretation. Part of the mystery may be due to the need to determine their abundances in dwarfs from ultraviolet spectra, which are heavily contaminated by stronger lines whose identity is often unknown. We will provide clarification of their empirical behavior by adding high-resolution spectra near 2000A for two cool stars of low metallicity, 1/400 and 1/100 solar, and analyzing them together with similar spectra of other low-metallicity turnoff stars using all the latest tools. This includes incorporating newly-identified Fe I lines as they are found, comparing theoretical spectra for each star with high-resolution observations over all available optical and ultraviolet wavelengths, and comparing the results from two independent synthetic-spectrum approaches. This analysis should clarify current systematic errors in modeling and in line transition probabilities (gf-values). In so doing it will provide reliable abundances for a range of trans-Fe elements in extremely metal-poor stars, for quantitative comparison with a half-dozen viable models of their production. The results will shed light on the nature and time scales of production of these elusive elements, and their incorporation into stars that are relics of the earliest phase of our Galaxy.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14640

Program Title: Investigating the FUV Emission of Young M dwarfs with FUMES: the Far Ultraviolet M-dwarf Evolution Survey

Principal Investigator: John Pineda

PI Institution: California Institute of Technology

M dwarf stars have become attractive candidates for exoplanet searches and will be a main focus of the upcoming TESS mission, with the continued search for nearby potentially habitable worlds. However, the atmospheric characterization of these exoplanetary systems depends critically on the high energy stellar radiation environment from X-ray to NUV. Strong radiation at these energies can lead to atmospheric mass loss and is a strong driver of photochemistry in planetary atmospheres. Recently, the MUSCLES Treasury Survey (Cycles 19, 22) provided the first comprehensive assessment of the high energy radiation field around old, planet hosting M dwarfs. However, the habitability and potential for such exoplanetary atmospheres to develop life also depends on the evolution of the atmosphere and hence the evolution of the incident radiation field. The strong high energy spectrum of young M dwarfs can have devastating consequences for the potential habitability of a given system. We, thus, propose the Far Ultraviolet M-dwarf Evolution Survey (FUMES) to measure the strong FUV coronal/chromospheric emission features of young M dwarfs (12 - 650 Myr), e.g. He II, C IV, and S IV. FUMES will observe objects with a wide range of rotation rates to directly connect the emission features to the evolution of coronal heating and upper atmospheric structure, and provide observational benchmarks at young ages for models of M dwarf upper atmospheres. Building on results from MUSCLES, we will be able to estimate the whole high energy radiation field and establish the evolutionary picture of the incident radiation throughout the lifetime of exoplanetary systems around early-mid M dwarf hosts.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14782

Program Title: Is the atmosphere of the extremely irradiated exoplanet WASP-43b in a blow-off state?

Principal Investigator: Lorenzo Pino

PI Institution: Universita degli Studi di Padova

In the past months we have obtained evidence that an unusual phenomenon is happening in the atmosphere of one of the Hot Jupiters with shortest period. High-resolution spectroscopy from the ground reveals a transit spectrum where the sodium absorption signal from the planet peaks at 2-3%, which is larger than the planet transit depth in white light and 100 times larger than the well HST-established detection of sodium in HD 209458b (Charbonneau et al. 2002). Only in the UV have such large signatures been observed, for lighter hydrogen, carbon and oxygen atoms being blown-off by hydrodynamical atmospheric escape. So far, sodium atoms have never been observed higher than the thermosphere, where they should get promptly ionized.
Analysis of ground-based data is challenging because the spectroscopic signatures can be mimicked by the Earth atmosphere, and a sophisticated removal of telluric contamination is necessary. Our observations show that an efficient telluric correction for this target, particularly faint in the sodium region, is impossible, making a space-based confirmation necessary. In a single transit, HST/STIS could obtain a 5-sigma confirmation of the signal. This detection would unambiguously show that the planetary atmosphere is in a state of extreme blow-off, with large exospheric densities allowing for a high recombination rate able to maintain sodium in a neutral state even high up in the atmosphere. This would represent the first constraint on atmospheric evaporation obtained in the optical, and would thus open a new, UV-independent path to the characterization of evaporating atmospheres, crucial in the post-HST era.

Proposal Category: GO

Scientific Category: Solar System

ID: 14616

Program Title: Primordial Triplicity: A Census of Hierarchical Triples in the Cold Classical Kuiper Belt

Principal Investigator: Simon Porter

PI Institution: Southwest Research Institute

We propose to observe six wide binaries in the cold classical Kuiper Belt (CCKB) with WFC3 to determine what fraction of them are actually triple systems. The only known hierarchical triple Kuiper Belt object is in the 3:2 Neptune resonance, (47171) 1999 TC36, and so far none have been discovered in the CCKB. Because the CCKB was the least disturbed part of the solar system during giant planet migration, it preserves many primordial aspects of planetesimal formation, including our wide binary targets. If even one of these wide binaries is actually a triple, it would strongly imply that the dominant binary formation mechanism was one that could also create triples. The leading such model is gravitational collapse, which requires that any triples and binaries were formed directly out a single cloud of material. JWST/NIRSpec could further test this theory by comparing the spectra of the three separate objects. In addition, hierarchical triples can uniquely provide independent mass determinations for all three objects. These masses can then be combined with thermal radius measurements from JWST/MIRI and ALMA to determine densities for all three objects in a hierarchical triple. Thus these proposed observations would enable JWST to peer into the interiors of some of the most primordial objects in the outer solar system.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14745

Program Title: Is there a substellar companion around the neutron star RX J0806.4-4123?

Principal Investigator: Bettina Posselt

PI Institution: The Pennsylvania State University

Deep near-infrared (NIR) observations from the ground, first with the VLT in the H-band and recently with Gemini in the J-band, showed indication of a faint (~24-25 mag) flux enhancement at the position of the young (~0.5 Myr) nearby (250 pc) isolated neutron star RX J0806.4-4123. The combined detection significance of these two independent NIR observations is 3.1sigma. Previous Hubble observations in the optical showed that there are no other objects within 2.5 arcsec, and established that the neutron star itself is very faint (STmag of 28 in the F475W filter). The neutron star is expected to be even fainter in the NIR, because young neutron stars have their emission maximum in the UV to X-ray range. Hence, emission from the neutron star surface cannot be responsible for the NIR flux enhancement at the position of RX J0806.4 -4123. The NIR emission could come from a young warm substellar companion which has about 13 Jupiter masses. We propose deep H-band observations of RX J0806.4-4123 in order to (i) confirm unambiguously the very faint NIR emission, (2) detect it with the required astrometric precision to enable the confirmation of the putative companion by studying its co-motion, (3) prepare follow-up JWST investigations.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Galaxies

ID: 14578

Program Title: Elongated Galaxies and the Emergence of Disks

Principal Investigator: Joel Primack

PI Institution: University of California - Santa Cruz

It was once generally assumed that galaxies start as disks, and that galactic spheroids form from disk mergers. However, the axis ratio distribution of high redshift HST images shows that most galaxies start not as disks but rather as elongated (prolate) stellar systems. Consistent with these observations, our high-resolution cosmological zoom-in galaxy simulations show that forming galaxies start as prolate stellar systems aligned with the cosmic dark matter filaments on which they form, and only become round stellar systems -- disks or spheroids -- when their centers become gravitationally dominated by ordinary matter. More massive simulated galaxies make this transition at redshifts $z > 2.5$, which should be accessible to JWST. In order to clarify the observational implications of the transition from elongated galaxies to galactic disks or spheroids, we propose to make realistic mock images and spectra from our simulations using our Sunrise code and compare them with HST images and grism spectra of star-forming galaxies. The distribution of axis ratio b/a versus semi-major axis a will make clearer the distinction between elongated and rounder galaxies. This will be further clarified by taking into account the amount of dust attenuation, which is predicted to be greater for edge-on disks than for edge-on elongated galaxies. Our mock images will allow us to quantify how the effects of dust and resolution make simulated images rounder, increasing the apparent axis ratio. We are also making mock images and spectra for large ground-based telescopes, which will allow further comparisons of predictions and observations. All outputs and codes will be publicly released.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14673

Program Title: A Definitive Test of Rotational Mixing in Massive Stars

Principal Investigator: Charles Proffitt

PI Institution: Space Telescope Science Institute

CNO processed surface material found in OB stars may originate either from internal mixing or from binary interaction, but incomplete boron depletion is an unambiguous sign of internal mixing. Existing boron observations indeed suggest that internal mixing occurs in some stars at a level that is consistent with the low end of the efficiency range predicted by the different models of rotationally driven mixing. However, current results are too sparse to directly confirm the expected relation between boron depletion and rotation, and leave room to interpret boron depletion through other mixing processes. We propose to observe boron in ten rather rapidly rotating early-B stars in the 10 Myr old open cluster NGC 3293. Together with our previous data on stars in this cluster, this increased sample with an expanded range of V sin(i) values will provide a definitive test of rotational mixing, and --- assuming that rotation actually drives the expected mixing --- will allow for a tight calibration of its efficiency, which is of critical importance for modeling the interior of massive stars, with wide implications for their advanced evolutionary stages.

Proposal Category: AR

Scientific Category: Blackholes

ID: 14579

Program Title: Modeling UV spectra of clumpy outflows in Seyfert galaxies

Principal Investigator: Daniel Proga

PI Institution: University of Nevada - Las Vegas

We propose to compare time-dependent and self-consistent theoretical models of discrete and multi-component UV absorbers in Seyfert galaxies with HST observations. Our modeling approach combines results from global simulations for the dynamics of clumpy outflows in AGN with a new quantitative theory for cloud formation, destruction, and acceleration based on high resolution local simulations. Our simulations include the realistic microphysical processes needed to make quantitative predictions for the UV spectral signatures expected for a given UV absorber. Our goal is to use these results in photoionizatoin and radiative transfer calculations designed to test the predictions of our model against observations of objects such as NGC 3783, NGC 4051, NGC 4593, NGC 5548, NGC 7469, Mrk 509, Mrk 279, and 1H 0419-57.
In so doing, we will address the following questions:
1) How do the outflow inhomogeneity and time variability affect spectra (e.g., the width, shape, position and number of absorption lines)?
2) How do UV spectra depend on the line of sight? and
3) Are multi-component UV absorbers and so-called X-ray warm absorbers related?

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14674

Program Title: Far UV Spectroscopy of Superluminous Supernovae

Principal Investigator: Robert Quimby

PI Institution: San Diego State University

Optical transient searches have yielded a diverse sample of supernovae with peak luminosities 10-100 times greater than common events. These superluminous supernovae (SLSN) have been shown to be especially UV bright, which make these objects ripe for discovery at high redshifts. Indeed, archival searches have already identified SLSN out to z=3.9 and the first dedicated searches for these events at z>3 are now underway. However, there is a dearth of rest-frame, far-UV (FUV; <1800 A) spectra of SLSN available to enable classification of these high redshift discoveries. FUV comparison spectra from optically confirmed SLSN are needed to rule out contaminating sources, such as AGN and tidal disruption events. These spectra will also provide a new window on the physical nature of SLSN, which remains a source of debate. Here we propose to more than double the entire sample SLSN with rest-frame FUV spectra. This sample will enable the first test of whether these transients can accurately be classified through only their FUV spectra.

Proposal Category: AR

Scientific Category: Galaxies

ID: 14580

Program Title: The Role of Galaxy Morphology in the Mass-Metallicity-SFR Relation

Principal Investigator: Marc Rafelski

PI Institution: NASA Goddard Space Flight Center

The mass-metallicity-SFR (M-Z-SFR) relation for galaxies gives insight into the accretion and outflow of gas. Heightened accretion should increase disk turbulence and the corresponding Jeans mass for gravitational instabilities, making star-formation clumpy, and it should also trigger star formation directly in large clumps where infalling clouds impact the disk. It follows that if the most irregular and clumpy galaxies are the most actively accreting, then they should be low-Z outliers in the M-Z-SFR relation. We propose to investigate for the first time whether any relationship exists between position on the M-Z-SFR relation and clumpy morphology. We will use WFC3/IR grism observations from several large surveys in the CANDELS fields to measure metallicities of intermediate redshift ($1.3<z<2.3$) galaxies. Of the ~1000 emission line galaxies sampled, we expect 30% to have a clumpy structure, determined from rest-frame optical imaging. We will measure SFRs from the emission lines, and combine them with SED based masses to compare clumpy galaxies with other disk galaxies of the same mass and redshift. We will investigate the existence and possible evolution of the M-Z-SFR relation at $z\sim1.5$ to $z\sim2$. We will also split the sample into bins of mass, morphology, and SFR using stacked spectra. The sample is large enough to get a statistically significant result. This proposed investigation would address the role that the structure of galaxies play in the M-Z-SFR relation, and investigate the redshift evolution of the relation and its possible dependence on galaxy morphology.

Proposal Category: AR

Scientific Category: Solar System

ID: 14581

Program Title: Spinny TNO Triples: New Analyses of the Spin+Orbit Dynamics of Haumea and 1996 TC36

Principal Investigator: Darin Ragozzine

PI Institution: Florida Institute of Technology

We propose to analyze archival data of Trans-Neptunian triples Haumea and 1996 TC36. The analysis requires a new dynamical analysis code focused on providing increased understanding of HST data. This code will allow for fast short-term orbital integration of multiple bodies, including the evolution of their spin periods and will be made publicly available. It will be applied to HST data from 8 Programs to: 1) detect or place upper limits on the photocenter variations of Haumea; 2) detect or place limits on the oblquity-induced precession of Hi'iaka, the outer satellite of Haumea; 3) determine the full n-body orbits of 1996 TC36 and interpret the implication of these results on the formation of this unique system; and 4) investigate the spin dynamics possible in the 1996 TC36 system to explain the elusive photometric variability of this target. The proposed work is a straightforward extension of previous analyses by the proposal team and, by focusing on information-rich triples, will improve our understanding of the formation and evolution of the outer solar system.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14746

Program Title: Stellar Laboratories: High-precision Atomic Physics with STIS

Principal Investigator: Thomas Rauch

PI Institution: Eberhard Karls Universitat, Tubingen

Stellar atmospheres are prime laboratories to determine atomic properties of highly ionized species. Since reliable metal opacities are crucial ingredients of many astrophysical simulations, we propose to exploit STIS's spectroscopic capabilities to obtain high-resolution, high-S/N spectra of three hot subdwarf stars that exhibit extremely high iron-group (calcium to nickel) abundances and, thus, are ideal objects to identify even weak spectral lines of these species. The precise spectral analysis by advanced non-LTE model-atmosphere techniques allows to determine photospheric properties accurately and subsequently derive relative weighted oscillator strengths of iron-group lines. This will establish an important benchmark test for available atomic-line lists of iron-group elements for ionization stages III to VI.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14605

Program Title: Spectral Time Series of the Cas A Supernova

Principal Investigator: Armin Rest

PI Institution: Space Telescope Science Institute

We propose to obtain time-resolved spectroscopy of the outburst of the enigmatic historical supernova Cas A using STIS spectroscopy of light scattered by a narrow filament of interstellar dust. Our group has identified recent, high-surface brightness filaments that are likely to provide high signal-to-noise reproduction of the evolving spectrum of the Cas A outburst using verified, published techniques developed by us.

The timescales to see any appreciable evolution in individual astrophysical objects are typically many orders of magnitudes larger than a human life. As a result, astronomers study large numbers of objects at different stages of their evolution to connect how a single object should change with time. Cas A can provide us with the ability, to look back in time to the point of explosion by observing its light echoes -- SN light scattered off of dust in the Milky Way, which causes a time delay in reaching us. In obtaining spectra of light echoes, we have been able to determine the maximum-light characteristics of the SN. Our goal here is to obtain a single STIS spectrum of a bright Cas A LE, which will provide us a time series of spectra and a spatially resolved light curve of the Cas A SN. With these data, we will measure the properties of the cooling envelope after the shock breakout of the SN to estimate the radius of the progenitor star. We will then be able to connect the progenitor star to the explosion to the SN to the SNR.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14711

Program Title: A Deep WFC3/IR Bulge Luminosity Function: toward the Hydrogen Burning Limit

Principal Investigator: R. Rich

PI Institution: University of California - Los Angeles

We propose to obtain WFC3/IR imagery in the bulge field Baade's Window (L,b=0.9,-3.9) that has first epoch WFC3/IR imaging. With its increase in area and sensitivity, WFC3 may make it possible to reach past the hydrogen burning limit for stars in the Galactic bulge. We propose to use the first epoch observations to reject foreground disk stars, via proper motion separation. Brown dwarf populations are being increasingly well characterized in the field and even in globular clusters. This will be the first attempt to study the brown dwarf population in the bulge and to define the hydrogen burning limit in the bulge. We will also derive a measure of the IMF derived from infrared photometry, where the lowest mass stars and brown dwarfs emit the bulk of their luminosity. The resulting deep infrared bulge image will also provide a first epoch for eventual deep JWST imaging of the bulge.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14747

Program Title: Lyman Continuum Escape Survey (LACES): Detecting Ionizing Radiation from z~3 LAEs with Powerful Optical Lines

Principal Investigator: Brant Robertson

PI Institution: University of California - Santa Cruz

Cosmic reionization represents the first epoch when galaxies affect the bulk properties of the universe. Extensive programs with HST have established that galaxy populations at redshifts z>6 are likely abundant and luminous enough to reionize the IGM during the first billion years after the Big Bang. The critical remaining issue is to constrain separately the production rate of Lyman continuum (LyC) photons per unit UV luminosity and the fraction f_esc that escape to reionize the IGM. HST has the unique capability to measure LyC directly from systems as distant as z~3 via WFC/UVIS F336W, but this critical capability will not be possible with JWST and is required to quantify the importance of future reionization epoch galaxies it discovers. The measurement of LyC with HST at z<3 from broadly selected LBGs and LAEs thus far has provided f_esc~0.01 -0.1, likely too low to allow for galaxies to trigger reionization by z~6 if f_esc does not increase with redshift. Key to this challenging measurement of f_esc is the target-selection. We therefore propose the Lyman Continuum Escape Survey (LACES), designed to measure f_esc for z~3 Lyman Alpha Emitters in the SSA22 field whose strong [OIII]/[OII] indicates vigorous LyC production. We can use the constraints on f_esc from HST and the measured [OIII]/[OII] ratios from ground-based IR spectroscopy to break the degeneracy between the f_esc and the production rate of ionizing photons. These observations, performed at the highest redshift where f_esc is directly measurable, then set the stage for using JWST in just a few years time to evaluate the role of galaxies in reionization by measuring their OIII emission at z>7.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14765

Program Title: The Unexplored Domains of the s-Process

Principal Investigator: Ian Roederer

PI Institution: University of Michigan

Understanding the origin of the elements is one of the major challenges of modern astrophysics. Abundance measurements in late-type stars are used to test nucleosynthesis models, and the models in turn reveal the nature of the progenitor star(s) that produced the metals observed today. Elements listed along the bottom two-thirds of the periodic table are produced by neutron-capture reactions, such as the r-process or s-process. Previous studies have expanded the chemical inventory of individual r-process-enhanced stars to >50 elements per star. Here, we propose to do the same for an s-process-enhanced star.

We propose new high-resolution STIS/E230H observations (2024-2301 Angstroms) of the star HD 196944, the UV-brightest s-process-enhanced metal-poor star in the sky. Lines of Se I, Mo II, Cd I, Cd II, Sn I, Sb I, Te I, Yb II, W II, Re II, Os II, Pt I, Pb II, and Bi I should be detectable in these observations because of the high spectral resolution and S/N. No star offers the opportunity to simultaneously detect all of these elements, and several of them could be detected for the first time. We will combine these NUV detections with optical detections to test many specific predictions of the s-process nucleosynthesis models in a way that has not been possible until now. This is particularly timely, for example, because s-process models have recently been shown to be uncertain at the termination point around Pb-Bi.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14675

Program Title: Metal Evolution and TrAnsport in the Large Magellanic Cloud (METAL): Probing Dust Evolution in Star Forming Galaxies

Principal Investigator: Julia Roman-Duval

PI Institution: Space Telescope Science Institute - ESA

Interstellar dust is a key component of galaxy evolution owing to its crucial role in the chemistry and radiative transfer in galaxies. Our interpretation of extragalactic SEDs and our understanding of galaxy evolution thus critically depend on an accurate characterization of how the dust content and properties in a galaxy vary with a range of environmental parameters (metallicity, density, dynamics). Recent observations and modeling suggest that dust grains must grow in the ISM to explain dust masses over cosmic times, leading to changes in the abundance, composition, size, and optical properties of dust grains with environment. We are however still lacking a comprehensive set of depletion and extinction curve measurements required to characterize dust evolution. We propose to obtain 33 COS and STIS low and medium resolution spectra in the LMC, which has 1/2 solar metallicity. Combined with an already observed set of 21 sightlines in the SMC, which has 1/5 solar metallicity, we will be able for the first time to measure the dust-to-gas ratio (D/G), dust-to-metal ratio (D/M), the dust composition, size, and optical properties as a function of surface density and dynamics, characterize dust growth and destruction timescales as a function of metallicity, and test the predicted relation between surface density, D/G, and D/M in models of galaxy evolution. In parallel, we will obtain WFC3 NUV-NIR imaging to map dust extinction parameters (AV, RV) in the vicinity of our targets and calibrate the FIR emissivity of dust. Our observations we will improve the accuracy of dust mass and extinction estimates in the local and high-redshift universe by up to an order of magnitude.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14748

Program Title: A close-up view of the star formation history of a young ultracompact dwarf

Principal Investigator: Aaron Romanowsky

PI Institution: San Jose State University

We have recently discovered a young ultracompact dwarf (UCD) in the dwarf spiral galaxy NGC 247. This is by far the nearest known UCD (3.6 Mpc), providing a unique opportunity to study the stellar populations of a UCD in detail. There are indications that this object originated as the nucleus of a smaller dwarf, stripped in a recent merger, and that it harbors multiple stellar populations. We propose to use WFC3-UVIS imaging to map out the internal color gradient of the UCD and to construct a color-magnitude diagram of its stars. We will be able to detect age spreads down to 100 Myr, which would provide an important point of reference for the mystery of multiple stellar populations in star clusters.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14807

Program Title: The primordial binary fraction in the young massive cluster Westerlund 2

Principal Investigator: Elena Sabbi

PI Institution: Space Telescope Science Institute

This is a photometric and astrometric proposal designed to probe the unexplored population of primordial low- and intermediate-mass binaries (mass range ~0.5 to 8 Mo) in the young massive cluster Westerlund 2. Our observations are tailored to identify short, intermediate and long period binaries and therefore ascertain, for the first time, the fraction of low- and intermediate-mass binaries in an environment that resembles the conditions of stellar density and UV radiation found during the early evolution of globular clusters, or starburtst galaxies. Knowledge of the orbital properties of soft and hard binaries over a broad range of masses can be used to constrain the models of star and cluster formation and evolution. A byproduct of this project will be an astrometric catalog of hundred of targets for spectroscopic follow up with JWST to study the early evolution of protoplanetary disks, which is one of the science themes of the Webb mission. If we can complete the requested observations in the next three cycles, we will be in the position to start the spectroscopic follow up in 2020, when JWST is fully commissioned. This makes the requested observations extremely timely.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14712

Program Title: HST-COS Ultraviolet Spectroscopy of B[e] Supergiant Stars in the Magellanic Clouds

Principal Investigator: Raghvendra Sahai

PI Institution: Jet Propulsion Laboratory

Massive stars end their lives as supernovae (SNe), which drive their host galaxy's chemical evolution by returning gas and dust to it. Some of the dust detected with SNe remnants should be created by the SN progenitor. It is therefore important to understand dusty mass loss from massive SN progenitors. One particularly poorly understood class of post-main sequence massive star, and therefore SN progenitor, is the B[e] supergiant (hereafter sgB[e]). SgB[e]s are mass-losing luminous B stars with a fast polar wind and a slower equatorial wind, the latter usually giving rise to dust production. Relatively few sgB[e]s are known. They usually have large thermal IR excesses due to large amounts of circumstellar dust, though recently-identified sgB[e]s in the low-metallicity Small Magellanic Cloud (SMC) have been found by Graus et al (2012) to be largely without circumstellar dust. To clarify their role as SN progenitors and the post-SN fate of the mass they lose, we request HST-COS ultraviolet (UV) spectra for a sample of 8 recently identified and 5 known sgB[e]s in the Large Magellanic Cloud and SMC. We will use the COS UV spectra to characterize the mass loss of the 3 recently-identified largely dustless sgB[e]s from the SMC, to compare to known dusty sgB[e]s. No other facility exists or will come into operation in the near future that can obtain these UV spectra. We will use the COS spectra to characterize the mass loss and determine basic stellar atmospheric parameters, which will reveal the evolutionary state of sgB[e]s and determine how their mass loss is related to their atmospheric parameters. This, in turn, will reveal their roles as mass-losing SN progenitors.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14713

Program Title: Binarity and Accretion Activity in AGB Stars with Variable UV and X-Ray Emission

Principal Investigator: Raghvendra Sahai

PI Institution: Jet Propulsion Laboratory

The dramatic changes in the geometry and dynamics of the mass-ejection during the AGB-to-PN transformation are widely believed to be due to binarity and associated accretion processes, but observational probes are lacking. We propose to obtain multi-epoch UV spectra of two late-spectral-type AGB stars, Y Gem and EY Hya, that belong to a newly-discovered class of AGB stars showing strong and variable FUV fluxes ("fuvAGB" stars) and hard X-ray emission -- suggestive of variable accretion of matter onto an accretion disk in a binary system. The companions are either low-mass main-sequence stars or cold white dwarfs. The proposed study will provide robust confirmation of, and constraints on, our accretion-activity model for these objects.

Y Gem and EY Hya represent the two main observational paths taken during post-AGB (pAGB) evolution: one leading to preplanetary nebulae (PPN) and the other to disk-prominent pAGB objects (dpAGB). Both dpAGBs and PPNe possess dusty circumstellar disks/torii, but, unlike dpAGBs, PPNs also show prominent extended nebulosities. We will fit the continuum to derive the temperature and size of the accretion hot-spot, and using CLOUDY modelling, fit the emission lines to provide constraints on the physical parameters of the accreting flow. The line profiles, if resolved, will reveal the nature of the companion stars. Our study will probe the early formation phase of bound disks in binary AGB stars, and provide valuable insights into the binary-induced accretion processes that make such disks, which have long been theorized to drive collimated outflows that produce aspherical morphologies in post-AGB objects.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14783

Program Title: Detecting Isolated Black Holes through Astrometric Microlensing

Principal Investigator: Kailash Sahu

PI Institution: Space Telescope Science Institute

A significant fraction of the mass of an old stellar population should be in the form of non-luminous, isolated black holes (BHs). Yet there has never been an unambiguous detection of a solitary BH--not surprisingly, since they emit essentially no radiation.

The only technique available to detect such isolated BHs is astrometric microlensing---the relativistic deflection of light from background stars. HST is the only instrument currently capable of detecting such tiny deflections. We have underway a multi-year program of HST high-precision astrometry of long-duration microlensing events in the Galactic bulge, using the WFC3 camera. Our aim is the first detection of stellar-mass black holes, by monitoring five optimally selected events.

Our program has met with success, with clear detections of the deflections, indicative of non-luminous massive lenses in 3 cases. However, for these long-duration ($T_E > 100$ days) events, the deflection due to microlensing is present at all our observed epochs, which causes some degeneracy between the proper motion (PM) and the deflection, making the mass estimate uncertain. The deflection due to microlensing is now neglible, so observations at this stage can unambiguously determine the PM, and remove this degeneracy. For 2 of our targets, we need 2 observations spaced by about one year to unambiguously determine the PM. The other target is a high-amplification event for which the deflection at the peak was negligible, so only one more observation will provide an unambiguous measurement of the PM. We thus need 5 orbits, which will lead to a robust determination of the lens masses, thus completing the original objectives of the program.

Proposal Category: AR

Scientific Category: Blackholes

ID: 14582

Program Title: Black Holes in Dwarf Galaxies: Growth and Impact

Principal Investigator: Laura Sales

PI Institution: University of California - Riverside

Recent observations have confirmed the presence of massive black holes (BHs) populating the centers of some dwarf galaxies. It is unclear how these BHs could assemble in such hosts --where most of the stars are born in-situ without significant contributions from mergers. HST observations of dwarf galaxies have also revealed an extraordinary diversity in their star-formation histories. We propose to use cosmological hydrodynamical simulations to study the assembly of BHs in low mass galaxies and evaluate their associated feedback effects. We will simulate a set of 10 dwarf halos with the AREPO code using several models for stellar and BH feedback. We will explore the link between the final BH mass and the evolutionary history in dwarfs. By comparing runs with/without BHs we will assess the effects of BH feedback on the star-formation histories of the dwarfs and also on their observed final properties, such as radial gradients in stellar age, color and metallicity. Moreover, if BH feedback can couple efficiently to the ISM, it might help transforming the inner dark matter density profile from cusps to cores. We will explore this possibility in our runs using both: 3D information from gas and stars but also creating mock line-of-sight velocity maps in order to gauge the observability of this effect in gas/stellar rotation curves. Our project not only addresses but also connects several recent and independent HST observations of dwarf galaxies, helping to build up a comprehensive understanding of how/when BHs can grow in dwarfs, and what are the smoking-gun signatures of BH feedback on the final properties of faint hosts.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Galaxies

ID: 14583

Program Title: Globular clusters and environmental effects in galaxy clusters

Principal Investigator: Laura Sales

PI Institution: University of California - Riverside

Globular clusters are old compact stellar systems orbiting around galaxies of all types. Tens of thousands of them can also be found populating the intra-cluster regions of nearby galaxy clusters like Virgo and Coma. Thanks to the HST Frontier Fields program, GCs are starting now to be detected also in intermediate redshift clusters. Yet, despite their ubiquity, a theoretical model for the formation and evolution of GCs is still missing, especially within the cosmological context.

Here we propose to use cosmological hydrodynamical simulations of 18 galaxy clusters coupled to a post-processing GC formation model to explore the assembly of galaxies in clusters together with their expected GC population. The method, which has already been implemented and tested, will allow us to characterize for the first time the number, radial distribution and kinematics of GCs in clusters, with products directly comparable to observational maps. We will explore cluster-to-cluster variations and also characterize the build up of the intra-cluster component of GCs with time.

As the method relies on a detailed study of the star-formation history of galaxies, we will jointly constrain the predicted quenching time-scales for satellites and the occurrence of starburst events associated to infall and orbital pericenters of galaxies in massive clusters. This will inform further studies on the distribution, velocity and properties of post-starburst galaxies in past, ongoing and future HST programs.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14676

Program Title: Two New Local Volume Dwarfs Associated with Compact High Velocity Clouds: Distance, Structure and Star Formation History

Principal Investigator: David Sand

PI Institution: Texas Tech University

We request two filter HST imaging (F606W and F814W) to study the properties of two faint, isolated dwarf galaxies discovered based on their association with HI compact high velocity clouds -- a potentially new class of young, gas-rich dwarf galaxy. This data will provide crucial information on how low mass galaxies form in isolation (the dwarfs have no plausible neighbor within ~700 kpc), and serve as useful reference objects for interpreting the faint dwarfs in the Local Group. Understanding the numbers, luminosities, and star formation histories of the faintest dwarf galaxies on the outskirts of the Local Group and beyond are a frontier area for comparisons between CDM predictions and observations. With current data, it is clear these dwarfs have ongoing star formation, but we can only constrain their distance to lie between $2.5 < D < 10$ Mpc -- we propose HST optical imaging to determine the galaxies' distance, extent, and star formation history. Only HST can provide the resolution and depth necessary to characterize this emerging class of objects, and we will compare and contrast their physical properties with dwarfs in the Local Group and gas-rich dwarf irregulars in the Local Volume.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14617

Program Title: Auroral properties of the brown dwarf LSR J1835 + 3259: The UV perspective

Principal Investigator: Joachim Saur

PI Institution: Universitat zu Koeln

Auroral activity has been observed for the first time on an object outside of the solar system, i.e., on the brown dwarf LSR J1835 + 3259 (Hallinan et al. 2015). The auroral emission has been identified only through observations at radio wavelengths and the Balmer lines combined with detailed modeling of their light curves. We propose to observe this brown dwarf within five orbits to characterize its UV emission over a broad spectral range. (a) Our observations will be an entirely different approach to model-independently establish the auroral emission of the brown dwarf. (b) These observations will essentially test weather the aurora on LSR 1835 + 3259 is a giganticly-upscaled version from Jupiter. (c) Observations over a significant range in UV wavelength provide crucial information about the nature of the auroral accelerator mechanisms and magnetospheric propertis of the brown dwarf particularly when combined with observations at other wavelengths. These observations together with theory of spectral and temporal auroral emissions thus provide a new means to explore the plasma properties and the physical processes in the magnetosphere of the brown dwarf. It will allow models of aurora generation extensively tested by in-situ spacecraft observations in our solar system to probe extra-solar objects.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14749

Program Title: Low redshift Lyman-alpha blobs

Principal Investigator: Mischa Schirmer

PI Institution: Gemini Observatory, Southern Operations

Lyman-alpha blobs (LABs) are luminous nebula at redshifts of 2 and beyond. Their nature and ionization sources are mysterious. The lack of accessible diagnostic emission lines and the poorly understood Lyman-alpha escape mechanism have so far prevented a consistent physical picture of LABs. We suggest that many LABs harbor transient AGN that have recently and quickly faded from our view; the Ly-alpha photons from the earlier quasar phase, however, are resonantly scattered and slowly released over times much longer than the LABs' light crossing time. These ionization echoes naturally explain the severe power deficits observed in LABs. We have identified a rare population of ultra-luminous [OIII] ionization echoes around transient AGN at redshifts z=0.3. They share many characteristics of LABs, including high Lyman-alpha luminosities of up to 7e43 erg/s as suggested by GALEX FUV images. We ask to observe three targets to verify the strong Lyman-alpha emission using ACS/SBC. This would prove that LABs may still exist in the Universe 7 billion years later than most other LABs known. It would also show that fading AGN explain the power deficits of many LABs, solving a puzzle that has been standing for over a decade. This proposal exploits the unique far-UV capabilities of HST.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14698

Program Title: The first spectrally resolved Ha measurement of an accreting planet

Principal Investigator: Christian Schneider

PI Institution: European Space Agency - ESTEC

LkCa 15 b was recently detected in Halpha using AO enhanced imaging and we propose to follow-up on this detection with HST STIS observations to provide, for the first time, a velocity resolved profile of planetary Ha emission. The velocity shift of the Ha emission is related to the planetary accretion mode, magnetospheric or boundary layer accretion. If a velocity shift is found that is close to the free-fall velocity, this would point to magnetospheric accretion, and thus, would provide evidence of early planetary magnetic fields.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14714

Program Title: An Extinction Probe Through the HD 107146 Debris Ring: Taking Unique Advantage of a Background Galaxy Transit

Principal Investigator: Glenn Schneider

PI Institution: University of Arizona

We propose a 3-cycle GO program utilizing a total of HST 30 orbits to directly measure and map the line-of-sight optical depth through the brightest sector of the HD 107146 solar-analog debris ring by ring-transit differential photometry of a bright (compared to the disk), spatially extended, background galaxy. We will advantageously exploit its serendipitously unique and experiment-enabling high proper motion reflex trajectory w.r.t. the galaxy back-lighting a sectional slice the exoplanetary debris system (EDS) with a 2D grid of multiple sight-lines through the nearly face-on disk over time. These measures (the only opportunity for such in remaining HST lifetime) will uniquely provide unambiguous extinction/optical depth constraints to better elucidate the physical properties of the debris particles in this otherwise well studied EDS. With these and prior data we will: (a) disambiguate inferred particle spatial, size, and mass density distributions otherwise conflated with debris material optical property dependencies, (b) better constrain the posited pathways for planetary debris dust production mechanisms in EDSs (e.g., catastrophic collisions of parent bodies, dust-production cascades, cratering events, etc.) and (c) search for and discriminated between "clumps ", "bumps ", and "clouds" of collisional debris of varying particle (and mass) densities. This investigation was enabled in forethought by mapping the galaxy surface brightness out-of-transit in a comprehensive 2011 precursor study (HST GO/12228) using exactly the same STIS instrumental configuration with multi-roll PSF template subtracted coronagraphy we propose for the upcoming ring transit opportunity.

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14677

Program Title: Probing the most distant high-mass galaxy clusters from SPT with HST weak lensing observations

Principal Investigator: Tim Schrabback

PI Institution: Universitat Bonn, Argelander Institute for Astronomy

We propose an HST weak gravitational lensing study of nine high-mass galaxy clusters which constitute the strongest Sunyaev-Zel'dovich (SZ) detections in the 2500 deg^2 South Pole Telescope SZ Survey at redshifts z>1.2. These measurements will provide the first weak lensing constraints on the cluster mass scale at such high redshifts (median ~1.4) for an SZ-selected cluster sample, enabling astrophysical and cosmological investigations in a previously unexplored regime.

The proposed program will complete a very rich multi-wavelength data set that also includes Spitzer and deep Chandra observations for all clusters. By incorporating existing observations and exploiting Continuous Viewing Zone opportunities we can complete HST imaging in three high-throughput filters out to the clusters' virial radii within a moderate orbit request. These data will provide both key components needed for the weak lensing analysis: robust shape measurements and the photometric removal of cluster members and preferential selection of the lensed background galaxies.

This program provides an important step to prepare for investigations of much larger cluster samples, which will soon be available at these redshifts thanks to the latest generation of SZ experiments.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14678

Program Title: Whimper of a Bang: Documenting the Final Days of the Nearby Type Ia Supernova 2011fe

Principal Investigator: Benjamin Shappee

PI Institution: Carnegie Institution of Washington

Even though SNe Ia are crucial to cosmological studies as distance indicators, the exact nature of these systems remains theoreltically ambiguous and observationally elusive. However, there is a new hope. The very late-time light curves of SNe Ia harbor important clues to the natures of their progenitor systems. First, the ejecta from the SN will shock heat a non-degenerate companion, leaving it luminous and visible at very late times after the SN has faded . Second, due to nucleosynthetic effects during the explosion, single and double degenerate SNe Ia models are predicted to produce vastly differing amounts of 57Co and 55Fe. 57Co and 55Fe dominate the power of the very late time light curves of SNe Ia after >1050 days after the initial explosion. Broadband observations of the bolometric luminosity at these epochs have the ability to measure the ratio of these two isotopes and thus discriminate between progenitor models. As the brightest SN Ia in nearly 40 years, SN 2011fe offers a prime opportunity to follow a SN Ia to such late epochs. Here we propose HST WFC3 optical and IR photometry of SN 2011fe to observe the transition from a 57Co to a 55Fe powered lightcurve and to constrain a possible shock-heated companion. These observations will place unique constraints on progenitor systems of SNe Ia. SN 2011fe, having been already observed for more than 1600 days and a factor of four million in flux. The observations proposed here would follow SN 2011fe to an epoch 2.5 times later than any other SNe Ia. SN 2011fe is likely to remain the best studied normal SN Ia of our generation and if these observations are not made now, they will likely never be done with Hubble.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14618

Program Title: Ultraviolet Flashers in M87: Rapidly Recurring Novae as SNIa Progenitors

Principal Investigator: Michael Shara

PI Institution: American Museum of Natural History

The recent discovery of a recurrent nova erupting every six months in M31, and simultaneous development of a consistent theoretical/numerical model for growing white dwarfs (WDs) to the Chandrasekhar limit, points the way to locating UV-bright SNIa progenitors in galaxies. We propose to monitor M87 with a cadence of 5 days over a 9 month-long span to 1) detect all the NUV-bright, near-Chandrasekhar mass WDs accreting at high enough rates to become SNIa in the next ~ 200,000 years; 2) determine their eruption frequency distribution, which is diagnostic of the underlying white dwarf accretion rates; 3) test nova modelers' prediction that recurrent novae can never erupt more frequently that once in 45 days; 4) definitively determine the rate Rnova of nova eruptions in M87; 5) confront population synthesis models predictions of Rnova with our observationally determined value; and 6) check the claim (observed in M31) that 20-41% of all nova WDs have red giant secondaries. A free bonus of these observations will be the deepest-ever NUV image of the M87 jet, and the highest cadence ever sequence of images of the jet, which includes knots mysteriously varying in brightness by up to 5 magnitudes.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14784

Program Title: HAZMAT: Habitable Zones and M dwarf Activity across Time

Principal Investigator: Evgenya Shkolnik

PI Institution: Arizona State University

Because M dwarfs make up 75% of the stars in our galaxy and 50% of them host small planets in the habitable zone (HZ), most of the detectable HZ planets must orbit M dwarfs. The star's UV radiation can destroy or alter the planet's atmosphere, which is a necessary condition for detectable surface life. Assessing the lifetime exposure of a planet to stellar UV radiation is critical to our understanding of both the evolution of life and our ability to identify it. We propose to observe a statistical sample of early M stars with well-determined ages to map the evolution of the full UV spectral range. We will use the diagnostic near-UV and far-UV emission lines accessible only with HST's COS to guide new upper-atmosphere models and produce the full stellar spectrum for a wide range of ages. These empirically-guided models will predict the unobservable extreme-UV fluxes, which most strongly affect the heating and erosion of planetary atmospheres. Our carefully-constructed sample consists of cluster or young moving group (YMG) members at ages during the greatest UV evolution. We will target 12 highly-active Tuc-Hor YMG members (40 Myr), 10 intermediately-active Hyades members (650 Myr), and 10 weakly-active old M dwarfs (~Gyr). This program will provide the stellar and planetary communities with a comprehensive study of the UV history of M stars, a realistic full-wavelength grid of model spectra, and tell us which planets in the canonical HZ are most likely to be habitable.

Proposal Category: AR

Scientific Category: Blackholes

ID: 14584

Program Title: Observational Corollaries of Proto-AGN: Understanding Formation of Supermassive Black Hole Seeds

Principal Investigator: Isaac Shlosman

PI Institution: University of Kentucky

Formation of supermassive black holes (SMBHs) is still an enigma. Recent detections of high-z quasars which harbor massive SMBHs provide a challenge to models of structure buildup in the universe. Main alternatives for the formation of SMBH seeds are (1) remnants of Population III stars, and (2) a direct baryonic collapse within dark matter (DM) halos of ~10^8 Mo --- first halos whose virial temperature exceeds ~10^4 K, and which can lead to the formation of proto-AGN --- luminous pre-SMBH objects. Potentially, this can involve both high-z objects as well as low-z dwarf galaxies in voids. We focus on the direct collapse in 10^8 Mo halos which circumvents the pitfalls of Pop III remnants. The collapse can proceed via a radiation pressure-supported "quasistar" --- with a modified blackbody continuum. Such a configuration requires a very efficient angular momentum transfer. Or, it can form a thick, differentially rotating, self-gravitating disk, which is associated with an X-ray-infrared continuum and Seyfert-level luminosity, anisotropic emission, massive bi-conical outflows, and will be a powerful source of the Ly-alpha emission. We propose to perform radiative transfer in the continuum and hydrogen lines (e.g., Lyman and Balmer), using our models of proto-AGN, and do it "on-the-fly" --- concurrently with the collapse. We shall test the path to quasistellar and disky proto-AGN, produce first synthetic spectra of proto-AGN, and address the issue of feasibility of their detection by the JWST. Finally, we shall develop the strategy of searching for these objects at high- and low-z, based on the specific features in the spectra and associated variability.

Proposal Category: SNAP

Scientific Category: Blackholes

ID: 14606

Program Title: Secular Black Hole Growth and Feedback in Merger-Free Galaxies

Principal Investigator: Brooke Simmons

PI Institution: University of California - San Diego

We will measure the merger-free galaxy-black hole mass relation for the first time, using a unique, newly-discovered sample of luminous active galactic nuclei (AGN) hosted in galaxies that have not grown via mergers. Our preliminary study has shown that supermassive black holes (SMBHs) in bulgeless galaxies -- i.e., galaxies that have never undergone a significant merger -- can have substantial growth: bulges are not required for the formation and growth of SMBHs. The proposed targets are broad-line AGN with black hole masses spanning a wide mass range (1e6 to >1e9 M_Sun) and hosted in strongly disk dominated galaxies (>80% light from a disk). This sample is an ideal laboratory for understanding merger-free black hole growth and its feedback on the host galaxy. HST imaging will allow us to disentangle bright nuclear emission from host galaxy, measure bulge type and strength, and identify bulgeless galaxies that have evolved under purely secular conditions. In addition, we will determine whether merger-free galaxies lie on the same SMBH-galaxy relation as galaxies with substantial past mergers, or whether merger-free growth results in a separate relation. The answer to this question has profound consequences for the role of baryon dynamics in driving black hole-galaxy co-evolution.

Proposal Category: AR

Scientific Category: Solar System

ID: 14585

Program Title: Understanding Jupiter's Cloud Scale and Energy Spectra from Archival Data

Principal Investigator: Amy Simon

PI Institution: NASA Goddard Space Flight Center

We propose an archival study of Hubble Jupiter data acquired from 1994 to 2016. We focus on datasets where at least one full rotation (360 deg coverage) is available in WFPC2 or WFC3. In the past, Jupiter global maps have been used to measure winds, and to identify large-scale structure evolution and atmospheric waves. However, global maps can also be used to investigate the spatial structure spectrum of passive tracers (size scales of cloud features). The kinetic energy spectrum can also be investigated when successive maps of Jupiter are produced on back-to-back rotations where the zonal and meridional winds can be measured, and such data were acquired in 2015 and 2016 from the OPAL program (GO13937/14334). The spectra of passive tracers and kinetic energy have spectral slopes dependent on the turbulent state of the atmosphere's dimensionality, coupling the observed cloud deck dynamics with much deeper regions. We will use maps in a variety of filters and acquired over 20 years to investigate Jupiter's turbulence spectra and how it varies with wavelength (and presumably altitude) and over time. This is directly tied to variations in the tropospheric weather layer and the transport of energy in the atmosphere, important for understanding circulation in unresolved exoplanet atmospheres.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14766

Program Title: ACS Imaging of the Ultra-Faint Dwarf Galaxy Reticulum II: Age-Dating a Unique Nucleosynthetic Event

Principal Investigator: Joshua Simon

PI Institution: Carnegie Institution of Washington

Recent chemical abundance measurements show that ~80% of the stars in the ultra-faint Milky Way satellite Reticulum II contain >100 times more r-process elements than stars in any other ultra-faint dwarf. These heavy elements must have been synthesized early in the formation history of Ret II in a single event that produced ~0.003 solar masses of r-process nuclei. The best explanation for these results is that a rare neutron star merger occurred in Ret II 12-13 Gyr ago. We propose HST/ACS imaging of Ret II to derive its star formation history, which will place new constraints on the origin of r-process elements in the galaxy. These measurements will be on the same photometric system as previous studies, enabling a careful comparison of the mean age and duration of star formation of Ret II and other ultra-faint dwarfs. We will determine whether the timing of the r-process enrichment is consistent with a neutron star merger, model the chemical evolution of Ret II, and set the stage for a comparison of the star formation and radioactive decay timescales of the system.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14767

Program Title: The Panchromatic Comparative Exoplanetary Treasury Program

Principal Investigator: David Sing

PI Institution: University of Exeter

HST has played the definitive role in the characterization of exoplanets and from the first planets available, we have learned that their atmospheres are incredibly diverse. The large number of transiting planets now available has prompted a new era of atmospheric studies, where wide scale comparative planetology is now possible. The atmospheric chemistry of cloud/haze formation and atmospheric mass-loss are a major outstanding issues in the field of exoplanets, and we seek to make progress gaining insight into their underlying physical process through comparative studies. Here we propose to use Hubble's full spectroscopic capabilities to produce the first large-scale, simultaneous UVOIR comparative study of exoplanets. With full wavelength coverage, an entire planet's atmosphere can be probed simultaneously and with sufficient numbers of planets, we can statistically compare their features with physical parameters for the first time. This panchromatic program will build a lasting HST legacy, providing the UV and blue-optical spectra unavailable to JWST. From these observations, chemistry over a wide range of physical environments will be probed, from the hottest condensates to much cooler planets where photochemical hazes could be present. Constraints on aerosol size and composition will help unlock our understanding of clouds and how they are suspended at such high altitudes. Notably, there have been no large transiting UV HST programs, and this panchromatic program will provide a fundamental legacy contribution to atmospheric escape of small exoplanets, where the mass loss can be significant and have a major impact on the evolution of the planet itself.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14641

Program Title: Short Orbital Period Recurrent Novae as Supernovae Type Ia Progenitors

Principal Investigator: Edward Sion

PI Institution: Villanova University

We propose to obtain the first ever far ultraviolet spectra of two critically important recurrent novae, IM Normae and CI Aquilae with HST COS. IM Normae and CI Aquilae, together with T Pyxidis, form a subclass of recurrent novae with short orbital periods (<1day), similar outburst characteristics in the optical, slow declines and complete diversity in optical quiescence. All are thought to contain massive white dwarfs accreting at a high rate. These two factors, as well as double white dwarf mergers, are central to identifying the dominant pathway(s) to the explosions of Type Ia supernovae. These are "standard candles of cosmology", which led to the discovery of the accelerating expansion of the universe in the presence of dark energy. We will (1) compare their FUV spectra to our earlier HST COS and STIS spectra of T Pyx, (2) determine their accretion rates by fitting their FUV continua and line spectra with state-of-the-art accretion disk models with vertical structure and NLTE hot white dwarf photospheres, (3) check for the detection of the underlying WD photosphere, (4) examine the N/C abundance ratio, (5) look for signs of magnetic accretion (truncated disks, very strong He II emission) and (6) look for FUV evidence of wind outflow in the form of P Cygni line structure and blue-shifted absorption features. We suspect CI Aql is evolving into a persistent supersoft x-ray source, and ultimately will explode as a SN Ia.

Proposal Category: AR

Scientific Category: Stellar Physics

ID: 14586

Program Title: Reconstructing the past outburst history of Eta Carinae from WFPC2 proper motions

Principal Investigator: Nathan Smith

PI Institution: University of Arizona

The HST archive contains multiple epochs of WFPC2 images of the nebula around Eta Carinae taken over a 15-year timespan, although only the earliest few years of data have been analyzed and published. The fact that all these images were taken with the same instrument, with the same pixel sampling and field distortion, makes them an invaluable resource for accurately measuring the expanding ejecta. The goal of a previously accepted AR proposal was to analyze the full set of appropriate continuum-filter HST images to place precise constraints on the avereage ejection date of the Homunculus Nebula; this analysis is now complete (Smith et al 2016) and the nebula appears to have been ejected in the second half of 1847. Here we propose to continue this project by constraining the motion of the more extended and much older "Outer Ejecta" around Eta Carinae. Older material outside the main bipolar nebula traces previous major outbursts of the star with no recorded historical observations. We propose an ambitious reduction and analysis of the complete WFPC2 imaging dataset of Eta Car. These data can reconstruct its violent mass-loss history over the past thousand years. We have already started this by analyzing two epochs of ACS F658N images, and astonishingly, these data suggested two previous eruptions in the 13th and 15th centuries assuming ballistic motion. WFPC2 images will extend the baseline by 10 yr, and critically, more than 2 epochs allow us to measure any deceleration in the ejecta. We will also analyze Doppler shifts in ground-based spectra in order to reconstruct the 3D geometry of past mass ejection. This AR proposal will fund the final year of a PhD thesis.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14768

Program Title: UV Signatures of Shock Interaction in an Eta Carinae Analog

Principal Investigator: Nathan Smith

PI Institution: University of Arizona

The optical transient in the dwarf galaxy UGC2773 that was discovered in 2009 (called UGC2773-OT) has proven to be the best known extragalactic analog of the 19th century giant luminous blue variable (LBV) eruption of Eta Carinae. While most non-supernova transients of comparable peak luminosity fade in about 100 days, UGC2773-OT is the only one that has remained in eruption for a decade, like Eta Car. Moreover, spectra of Eta Car's light echoes most closely resemble spectra of UGC2773-OT, and it had a luminous blue progenitor detected by HST. Current debate about Eta Car's eruption centers around it being powered by a super-Eddington wind, or alternatively, an explosion where a shock interacting with dense circumstellar material (CSM) powers the visible display. Interestingly, a recent study of the optical spectra of UGC2773-OT showed evidence of shock emission reminscent of some Type IIn supernovae that are also powered by shock interaction. At visible wavelengths, however, the signatures of a very strong wind can sometimes be similar to those seen in some Type IIn supernovae. Here we propose UV spectroscopy of UGC~2773-OT to either confirm or refute the hypothesis that it has strong shock interaction occuring, by looking for unambiguous UV signatures of shock excitation. While an extremely dense wind with a pseudo photosphere will tend to fall off in flux in the UV due to line blanketing, shock diagnostics like MgII 2800, HeII 1641, and some other lines are expected to be bright in the UV, as they are in Type IIn supernovae. This is a rare opportunity to provide a fairly clean test to discriminate between two quite different models.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Galaxies
ID:	14699
Program Title:	The hosts of the early ionized bubbles: the nature and diversity of the most luminous Lyman-alpha emitters at z~6-7
Principal Investigator:	David Sobral
PI Institution:	Lancaster University

The most distant sources stringently test models of early galaxy formation and of the epoch of re-ionisation. Recently, we have spectroscopically confirmed the brightest Lyman-alpha (Lya) emitters at z~7 (e.g. CR7; Sobral et al. 2015) and showed that luminous Lya emitters at z~7 (e.g. Himiko) are not as rare as previously thought. Surprisingly, we find even higher luminosity Lya emitters at z = 6.6 (Matthee et al. 2015) and at z=5.7, implying that at these high redshifts the bright end of the Lya luminosity function is likely a power-law, and certainly not a Schechter function. We are also revealing, for the first time, the potential diversity and unexpected nature of luminous Lya emitters at z~6-7. CR7 is already the subject of a wide variety of papers exploring its PopIII-like or direct collapse black hole (DCBH) nature; now is the time to study the first sample of CR7-like sources at z~6-7.

Our aim is to study the first sample of ~10 luminous Lya emitters just before and after the epoch of re-ionisation, in order to unveil their nature and evolution. Are they capable of ionising their own bubbles (allowing their Lya to be observable)? Are all sources split into multiple components? What are their typical (and range of) UV luminosities and sizes? Do they always contain redder/older stellar populations, likely responsible for previously ionizing a local bubble? Can some of them be lensed? We will be able to address these questions for the first time, by obtaining WFC3 observations of MASOSA and other 9 newly discovered luminous Lya emitters at z=5.7 and 6.6 in the SA22 field and directly compare them with the same observations already done for CR7+Himiko.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	GO
Scientific Category:	Stellar Populations
ID:	14769
Program Title:	Proper Motions of Two Local Prototype Dwarf Elliptical Galaxies NGC 147 and NGC 185
Principal Investigator:	Sangmo Sohn
PI Institution:	The Johns Hopkins University

The factors governing the quenching of dwarf galaxies are of great importance to understanding galaxy formation. Deep HST photometry shows a significant difference in the quenching times between the otherwise seemingly similar dwarf elliptical galaxies NGC 147 and 185 in the halo of M31. The two galaxies are found close together on the sky with similar line-of-sight velocities, suggestive of a shared history. Measuring proper motions (PMs) of these two systems to constrain their orbits will allow us to differentiate between various quenching scenarios. We propose to target the same fields as the earlier deep HST observations, using the same instruments and orientations. For each galaxy, both the primary ACS and the parallel WFC3 fields will be used for PM measurments. We will use the same advanced techniques that allowed us to measure the PMs of M31 and Leo I. Thanks to the time baseline of 8 years, we expect to obtain one-dimensional PM accuracy of 25 km/s, far smaller than the velocity dispersion in the M31 halo. PM results will show whether these galaxies share a common dynamical history. We will convert the orbital energy of each galaxy to infall time, using correlations found in cosmological simulations. We will also compute orbits for both galaxies to find their pericenters as they orbit M31 and relate those to their tidal distortions, stellar streams, and differing gas content. Both galaxies also belong to M31's surprising "plane of satellites", and the PMs we obtain will test the nature of this plane. Together, these results will isolate the factors responsible for their differing quenching times. These will be the first PM measurements for dwarf galaxies of M31.

Proposal Category: GO

Scientific Category: Stellar Populations

ID: 14770

Program Title: Proper Motions of the Crater-Leo Group: Testing the Group Infall Scenario

Principal Investigator: Sangmo Sohn

PI Institution: The Johns Hopkins University

While substantial progress has been made in studying the dynamical properties of individual Milky Way (MW) satellites, groups of satellites have gained much interests only recently although such groups have long been predicted by cosmological simulations. Testing the picture of group infall requires the identification of candidate systems and measurement of their full 6D phase-space coordinates to assess the validity of a common orbital history. The Crater-Leo group of MW satellites (Crater 1/2, Leo II, IV, and V) constitute the best such candidates. Their numbers, positions, distances, line-of-sight velocities, and star formation histories are all indicative of a common origin. However, proper motion (PM) is the one key ingredient missing to study these valuable objects in great detail. Leo II has existing multi-epoch data in the archive and Leo IV will soon have PMs from our ongoing HST program. We propose to measure the PMs of the other 3 objects that belong to the Crater-Leo Group: Crater 1/2 and Leo V. These PMs will allow us to definitively confirm or rule out associations. There is a high chance that our measurements will identify the first known group of low-mass MW satellites, a key milestone towards ratifying LCDM theory. This finding will revolutionize research in near field cosmology by allowing to study the formation histories of dwarf galaxy having originated from, and interacted with, the same group environment. Regardless of the outcome, the newly defined orbits of these systems will furthermore place powerful constraints on the potential of the MW halo at distances where few probes exist.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14659

Program Title: Imaging Spectroscopy of V339 Del: Testing Models of Gamma-Ray Production in Classical Novae

Principal Investigator: Jennifer Sokoloski

PI Institution: Columbia University in the City of New York

If you were in the northern hemisphere in August of 2013 and looked up at night, you might have seen 339~Del (Nova Del 2013). Many people did. Numerous telescopes and satellite observatories did, generating an impressive trove of valuable, high-quality data spanning the EM spectrum from the radio to gamma-rays. Here we propose to use the high spatial resolution of HST to disentangle the structure and kinematics of the flows that produced this radiation. By so doing, we will test early ideas for how normal novae produce GeV gamma-rays. During the past six years, the Fermi satellite has identified novae as a new class of gamma-ray sources. To explain this ubiquitous gamma-ray emission, novae must contain powerful shocks that efficiently accelerate particles. Detailed radio plus HST observations of the first bright, northern classical nova with detected gamma-rays ---V959 Mon --- indicated that a fast flow from the eruptive white dwarf collided with a slower, denser flow in the orbital plane of the binary. This equatorial waist collimated the faster flow into two lobes. Given that many novae show evidence for equatorial density enhancements and bi-polar structure, the picture developed specifically for gamma-ray production in V959~Mon might apply more generally. As the second bright, northern gamma-ray nova, V339~Del is ideal for testing this contention. Because of its expected sub-arcsec size, HST is required for this research. And because we expect V339~Del to fade quickly and few other well-observed gamma-ray novae exist, this work is extremely time critical.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14619

Program Title: Characterising the atmosphere of a uniquely low-density, sub-Saturn mass planet

Principal Investigator: Jessica Spake

PI Institution: University of Exeter

We propose to use HST and Spitzer to measure the transmission spectrum of the recently discovered, hot sub-Saturn mass exoplanet WASP-127b. Its low mass (0.19 Mj) and large radius (1.39 Rj) give it the lowest density of any exoplanet with a radial velocity measured mass. It has the largest predicted atmospheric scale height of any planet, and orbits a bright (V~10.2) star, making it an exceptional target for atmospheric characterisation via transmission spectroscopy. With HST and Spitzer, we will measure the full transmission spectrum from 0.3 to 5 microns, covering water, sodium, and potassium absorption features, and scattering by molecular hydrogen or haze. The Spitzer transit photometry at 3.6 and 4.5 microns will be used alongside the HST spectrum to break the low abundance/cloud degeneracy which prevents constraints being made on atmospheric metallicity. With a low mass of 0.19 Mj, this planet sits in an unexplored mass range at the very low-end of gas giant planets, making WASP-127b strategecally important for constraining the planetary mass-metallicity relationship, which is important for understanding planet formation mechanisms.

Proposal Category: GO

Scientific Category: Solar System

ID: 14755

Program Title: Understanding Callisto's Atmosphere

Principal Investigator: John Spencer

PI Institution: Southwest Research Institute

We plan to address first-order questions about the nature and origin of the mysterious atmosphere of Callisto, including its composition, longitudinal distribution, formation, and support mechanisms. This investigation is made possible by the remarkable sensitivity of the COS instrument, which has recently detected faint 1304 A and 1356 A O I emission from Callisto's leading / Jupiter-facing quadrant. The emission is probably due to dissociation of O2 molecules in Callisto's atmosphere by photo-electrons, and resonant scattering from an extended atomic O corona. We suspect, from Galileo ionospheric data, that the atmosphere may be much denser, and brighter in emission, on the trailing hemisphere, as expected for a sputter-generated atmosphere, and propose to test the sputter generation hypothesis with 4-orbit COS integrations on the leading and trailing hemispheres. If the trailing side emissions are indeed brighter, the improved SNR there will also allow much improved determination of atmospheric and coronal composition and optical depth. The observations will set the stage for, and aid in planning of, the extensive observations of Callisto's environment planned for the JUICE mission. Because Callisto's atmospheric oxygen emissions are indirectly illuminated by sunlight, which is uniform and quantifiable, it is much easier to understand atmospheric spatial distribution, and thus origin, than on Europa and Ganymede were emissions depend on magnetospheric excitation which is spatially variable and poorly understood. Callisto's atmosphere thus provides a unique chance to better understand the oxygen atmospheres of all the icy Galilean moons.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14679

Program Title: Extremely Metal Poor Galaxies with HST/COS: Completing the Groundwork for JWST

Principal Investigator: Daniel Stark

PI Institution: University of Arizona

Over the last year, our first glimpse of the spectral properties of z~6-8 galaxies has emerged. Deep UV spectra have revealed very prominent line emission from nebular CIII] and CIV, pointing to a hard radiation field of unknown origin. High resolution COS observations of local galaxies have recently revealed that UV spectra begin to approach those now being seen at z>6 at metallicities below a tenth solar, suggesting that metal poor massive stars may power the extreme line emission. These high-ionization UV lines will likely be one of the only tools we can use to characterize the spectra of the most distant (z=10-15) galaxies JWST will be able to detect; yet we are completely unprepared to interpret them. Very few nearby galaxies at the extreme metallicities expected in the reionization era have been observed with the necessary high-resolution UV spectrographs. Here we propose to remedy this shortcoming by obtaining COS UV spectra of 6 nearby galaxies at less than a tenth of solar metallicity. Using the G160M and G185M gratings, we will characterize the strength of four diagnostic UV lines (CIV, He II, OIII], CIII]) and stellar features in these nearby systems. The data will probe in detail the nature of massive stars in this neglected metallicity regime, and determine what factors control the production of extreme nebular UV emission lines. The spectra will be used to test and calibrate the UV spectral models that will become commonplace in the JWST era. The UV spectral database we will assemble can only be obtained with HST/COS and will provide the necessary empirical baseline to which reionization-era systems observed by JWST can be properly compared.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14642

Program Title: A Preparatory Program to Identify the Single Best Transiting Exoplanet for JWST Early Release Science

Principal Investigator: Kevin Stevenson

PI Institution: University of Chicago

JWST will revolutionize transiting exoplanet atmospheric science due to its capability for continuous, long-duration observations and, compared to existing space-based facilities, its larger collecting area, spectral coverage, and resolution. However, it is unclear precisely how well JWST will perform and which of its myriad instruments and observing modes will be best suited for transiting exoplanet studies. The Early Release Science (ERS) program was devised to provide early and open access to a broad suite of JWST science observations subject to key data analysis challenges so that the community can quickly build experience and develop a list of best observing practices prior to the Cycle 2 proposal deadline. In a recent paper, we identified 12 transiting exoplanets (dubbed "community targets") that may be suitable for time-series observations within the ERS program; however, a critical unknown for the most favorable targets is the presence of obscuring clouds. To properly assess each observing mode, it is vital that the selected community target has measurable and identifiable spectroscopic features.

We propose HST/WFC3 observations of four exoplanets to identify the single best target by first measuring the size of their 1.4-micron water vapor features. Next, we will perform follow-up Spitzer observations of the top two targets to determine the slopes in their infrared transmission spectra. Together, these measurements will provide the most robust determination of clouds/hazes with the minimum amount of telescope time. Cycle 24 is our final opportunity to identify suitable community targets with cloud-free atmospheres prior to the ERS proposal deadline in mid-2017.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14660

Program Title: Morphology and Orientation of QSO Absorber Host Galaxies at z<1.5 Detected with VLT/MUSE

Principal Investigator: Lorrie Straka

PI Institution: Sterrewacht Leiden

Gas accretion and galactic winds are two of the most important, but also most poorly understood ingredients of models for the evolution of galaxies. QSO absorption line spectroscopy enables us to study the gas around galaxies, nearly all of which is far too diffuse to see in emission. This unbiased method allows us to probe even low-mass galaxies, which dominate the galaxy number counts and are likely to be closest to absorbers, and is ideal for studying metal-enriched gas in galaxy outflows or inflows. Because outflowing gas is thought to be most prominent in the directions perpendicular to the disk, while infalling gas may be strongest in the plane of the disk, knowing the orientiation of the galaxy relative to the line of sight of the QSO is critical. However, the usefulness of absorption line studies is generally limited by the small number of galaxies at close impact parameters to the QSO line of sight for which redshifts are available. To remedy this, we have successfully used the MUSE integral field unit on the Very Large Telescope to detect and obtain redshifts for hundreds of galaxies < 250 kpc from the sight lines to 16 luminous QSOs at 0.4<z<1.5 for which high-quality archival HST/COS data (~200 orbits) is available. While MUSE is highly efficient at detecting and localizing galaxies close to QSO sight lines, the image quality is insufficient to determine the morphologies and orientations of the detected objects. We propose to use ACS/WFC to obtain high-resolution images of our MUSE fields in order to determine the relation between QSO absorbers (including HI, OVI, SiIV, CIV, NV, and MgII), and galaxy position angle and morphology.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14700

Program Title: Light Echoes and the Environments of SNe 2014J and 2016adj

Principal Investigator: Ben Sugerman

PI Institution: Goucher College

Light echoes are one of the most powerful and efficient probes of the structure and composition of dust in circumstellar and interstellar environments. Observations of light echoes provide exact three-dimensional (3-D) positions of dust while constraining its density, grain-size and chemical make-up. These can be used to study the evolutionary history of supernova (SN) progenitors, produce high-resolution maps of the structure and composition of interstellar media (ISM), and geometrically measure extragalactic distances. However, echoes pass through a given point only once, and only illuminate a thin slice of a complete structure at any given time, thus accomplishing meaningful science requires carefully-planned, repeated observations.

The Type Ia SN 2014J in M82, and the core-collapse SN 2016adj in Cen A are both nearby (~3.5 Mpc), highly reddened (A_V=2-4 mags), and were reported within the last year to have produced resolved light echoes. With 12 orbits of HST and 2.4 hours of Spitzer follow-up observations proposed here, we will map out much more of the 3-D geometry and measure the dust properties of numerous independent structures within the ISM of the host galaxies, and map out or constrain the presence of circumstellar material around each SN. These results can be further used to investigate why the extinction toward SN 2014J (R_V=1.4) differs from Galactic values; measure the geometric distances to both host galaxies; constrain the progenitor properties; test competing models of Type Ib/IIb SNe; and benchmark whether echoes can help us understand galactic feedback, by comparing the actual structures they reveal to ISM simulations.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14808

Program Title: SUbaru Supernovae with Hubble Infrared (SUSHI)

Principal Investigator: Nao Suzuki

PI Institution: Institute for Physics and Mathematics of the Universe

During the next two HST Cycles, the Subaru Strategic Program (SSP) will conduct a rolling search with Hyper Suprime-Cam (HSC) that will discover and study scores of very high quality SNe Ia up to redshift of ~1.5. However, above a redshift of one, the Subaru photometry will be limited to the UV and blue rest-frame of the SNe. By combining the HSC light curve with just one non-disruptive ToO observation and a "reference image" (after the SN has faded) from HST for each of 46 SNe, we will improve the dark energy Figure of Merit (FoM) obtainable from all past and present high-redshift SN searches by a factor of 2.3. This opportunity is unique. Because this search requires frequent changes of the massive HSC at the Subaru prime focus, it will not be repeated for the foreseeable future.

Proposal Category: AR

Scientific Category: Solar System

ID: 14587

Program Title: Geophysics using Hubble Space Telescope

Principal Investigator: Gonzalo Tancredi

PI Institution: Universidad de La Republica Facultad de Ciencias

We exploit Hubble Space Telescope (HST) as a cosmic ray detector to probe Earth's external magnetic field through analysis of the cosmic ray flux on HST instruments. We propose to analyze 100 000+ dark images obtained during 26 years of HST operation to calculate the flux of cosmic rays at an altitude of ~500 km above the surface and estimate variations in the external magnetic field, thereby complementing geophysical observatory measurements.

Our analysis will combine HST results with measurements of solar activity, cosmic ray flux on Earth's surface, and geomagnetic data to tease out external field variations. The addition of 26 years of HST data, including 10 years of measurements predating geomagnetic satellites, will provide invaluable, high-resolution observations of the geomagnetic field

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14771

Program Title: r-process kilonovae, short-duration GRBs, and EM counterparts to gravitational wave sources

Principal Investigator: Nial Tanvir

PI Institution: University of Leicester

Our HST observations of the short-duration gamma-ray burst GRB130603B showed an infrared excess, about a week (rest-frame) after the burst, consistent with expectations from models of an emerging 'kilonova' (aka. 'macronova') driven by the radioactive decay of newly-synthesised r-process elements. This directly supports the compact object merger hypothesis for short-duration GRBs, in which dynamically ejected neutron star material powers a radioactive transient. If confirmed in future events, this discovery also provides empirical evidence for a quasi-isotropic, electromagnetic signature of a prime target for gravitational wave (GW) detection by aLIGO/AdV, and suggests that kilonovae of this sort are likely sites of substantial (perhaps dominant) production of r-process elements in the universe. However, the ubiquity and range of behaviour of these events is entirely unknown; the kilonova luminosity is expected to depend on the ejecta mass and velocity, and also may be enhanced by ongoing energy input from the compact remnant. We need to establish their properties to inform searches of GW error boxes and quantify their contribution to the heavy element nucleosynthesis budget. Suitable SGRBs targets are rare, so intensive follow-up of any that occur is critical. Here we propose ToO observations (continuing our c23 campaign) of a low-redshift (z<~0.35) SGRB localised during cycle 24 to search for and characterise more fully any accompanying kilonova signal.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14620

Program Title: QSO and Galaxy Growth Probed by Faint Lya-Emitters

Principal Investigator: Ryan Trainor

PI Institution: University of California - Berkeley

We propose deep imaging of the stellar continuum of 84 faint Lyman-alpha-emitting galaxies (LAEs) surrounding a hyperluminous QSO at z=2.57. We have shown that these QSOs boost the Lyman-alpha emission of their nearby galaxies (a process known as fluorescence), allowing the direct characterization of the QSO ionizing field and the potential detection of galaxies independently of their stellar luminosities. However, the relative contributions of stellar and fluorescent Lyman-alpha emission are currently masked by the poorly-constrained stellar populations of these faint galaxies (R ~ 27; log(M*) ~ 8-9.5; L ~ 0.1 L*). Unlike typical broadband filters, the WFC3 F140W passband samples the stellar continuum at this redshift with minimal contamination by bright emission lines, and these wide-field images will allow us to map the stellar contribution to total luminosity out to large QSO-centric radii. Faint LAEs also exhibit characteristics that vastly expand the parameter space of galaxies selected by continuum colors alone: LAEs have weaker outflowing winds, less optically-thick gas, and a higher escape fraction of UV photons than continuum-selected galaxies. Robust measurements of the stellar masses and sizes of these galaxies are essential for understanding the efficiency and scaling of stellar feedback, star formation, and ionizing photon emission at low galaxy masses, and their morphologies will reveal how this feedback affects galaxy-scale structures and the observed anisotropic distributions of escaping gas and photons. Comparison to 182 continuum-selected galaxies (z~2-3) in the same field will reveal these properties as a function of stellar mass and galaxy structure.

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14701

Program Title: Is galaxy formation different during the epoch of reionization? Confirmation of the brightest ever candidate at redshift z>8

Principal Investigator: Michele Trenti

PI Institution: University of Melbourne

How bright can galaxies be during the epoch of reionization? Recent Hubble observations challenged prior expectations and led to the identification of two surprisingly luminous galaxies with spectroscopic confirmation within 600 Myr from the Big Bang: A source with m_AB=25.3 at z=8.7 and another with m_AB=26.0 at z=11.1. Such galaxies hint a tension with the assumption of a luminosity function (LF) with a Schechter (exponential) profile at the bright end, otherwise well established after reionization is complete. A clear excess of L>L* galaxies, if confirmed, would be a strong indication of a different physics of galaxy formation at play during the epoch of reionization. Leveraging upon the large-area pure-parallel BoRG survey, we identified a yet more luminous galaxy candidate at z>8, a source with m_AB=24.5, corresponding to M_AB=-22.8, almost ten times brighter than the Milky Way! The F105W dropout is detected at very high S/N in the IR, has no optical flux and a compact size (r_e=0."17) leading to a most likely redshift of z~8.4. However, a secondary peak in the redshift distribution is present at z~1.8 (p~10%). To exclude this solution and confirm the high-z nature of BoRG_0116+1425, we propose observations in the medium-band F098M filter. If the galaxy is an interloper, it will have m_AB~26.4 in F098M, while it will be undetected if at z>7.8. Since a Schechter-like LF predicts less than 0.002 galaxies as bright as BoRG_0116+1425 in the survey area, this single orbit proposal has the potential to unequivocally establish departure from a Schechter LF at confidence greater than 99.8%, supporting theoretical predictions of decreasing efficiency of AGN feedback at high-z

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14607

Program Title: Identify the signature of neutron star mergers through rapid Hubble observations of a short gamma-ray burst

Principal Investigator: Eleonora Troja

PI Institution: University of Maryland

The afterglow of some short gamma-ray bursts (GRBs) displays a late-time rebrightening, visible a few days after the GRB. Recent HST observations provided tantalizing evidence that such late-time bump could be explained as the emergence of the underlying kilonova emission. This would represent the incontrovertible signature of a neutron star merger, and the first direct link between short GRBs and their progenitors. If the kilonova interpretation is correct, it would also confirm that neutron star mergers are significant and possibly dominant sources of the heaviest elements (e.g. gold, platinum, uranium) in the Universe.
Here we ask for rapid HST follow-up observation of a nearby (z<0.4) short duration GRB in order to detect the expected kilonova bump, and to constrain the origin of the observed emission. Multi-color observations are critical to pin down the nature of the observed rebrightening, and to distinguish it from the standard afterglow. The proposed observations will provide the smoking gun evidence connecting short GRBs and neutron star mergers, and will serve as a powerful observational input in the new era of gravitational wave astronomy.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14643

Program Title: Imaging of three Ultra Diffuse Galaxies with measured stellar kinematics

Principal Investigator: Pieter van Dokkum

PI Institution: Yale University

In 2015 we discovered a new population of galaxies. Initially found in the Coma cluster, "Ultra Diffuse Galaxies", or UDGs, have the sizes of Milky Way-like galaxies but the luminosities of dwarf galaxies. We recently succeeded in measuring the absorption line kinematics of three Coma UDGs, using 20 hr integrations with DEIMOS on the Keck telescope. Surprisingly, the velocity dispersions of the galaxies span a large range, from ~20 km/s to ~80 km/s. The most straightforward interpretation is that UDGs span a very large range in dynamical mass, with the most massive UDGs having halos masses similar to that of the Milky Way. Here we propose to test this using deep HST imaging of the three UDGs with velocity dispersion measurements. The primary aim is to count their globular clusters: if the interpretation of the dispersions is correct, the galaxy with sigma=80 km/s should have ~10x more globular clusters than the galaxies with sigma=20-30 km/s. Secondary goals include an analysis of the central regions of the UDGs; a search for star forming regions; a measurement of the radial variation in ellipticity and position angle; and a search for faint satellites around them. With primary ACS/WFC and parallel WFC3/UVIS observations we can image all three UDGs with dynamical measurements, as well as a fourth spectroscopically confirmed Coma UDG, in two pointings.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14644

Program Title: Exploring the extremely low surface brightness sky: distances to 23 newly discovered objects in Dragonfly fields

Principal Investigator: Pieter van Dokkum

PI Institution: Yale University

We are obtaining deep, wide field images of nearby galaxies with the Dragonfly Telephoto Array. This telescope is optimized for low surface brightness imaging, and we are finding many low surface brightness objects in the Dragonfly fields. In Cycle 22 we obtained ACS imaging for 7 galaxies that we had discovered in a Dragonfly image of the galaxy M101. Unexpectedly, the ACS data show that only 3 of the galaxies are members of the M101 group, and the other 4 are very large "Ultra Diffuse Galaxies" (UDGs) at much greater distance. Building on our Cycle 22 program, here we request ACS imaging for 23 newly discovered low surface brightness objects in four Dragonfly fields centered on the galaxies NGC 1052, NGC 1084, NGC 3384, and NGC 4258. The immediate goals are to construct the satellite luminosity functions in these four fields and to constrain the number density of UDGs that are not in rich clusters. More generally, this complete sample of extremely low surface brightness objects provides the first systematic insight into galaxies whose brightness peaks at >25 mag/arcsec^2.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14645

Program Title: The Stellar Origins of Supernovae

Principal Investigator: Schuyler Van Dyk

PI Institution: California Institute of Technology

Supernovae (SNe) have a profound effect on galaxies, and have been used as precise cosmological probes, resulting in the Nobel-distinguished discovery of the accelerating Universe. They are clearly very important events deserving of intense study. Yet, even with over 9100 classified SNe, we know relatively little about the stars which give rise to these powerful explosions. The main limitation has been the lack of spatial resolution in pre-SN imaging data. However, since 1999 our team has been at the vanguard of directly identifying SN progenitor stars in HST images. From this exciting line of study, the emerging trend from 13 detections for Type II-Plateau SNe is that their progenitors appear to be relatively low mass (8 to 20 Msun) red supergiants, although more cases are needed. Additionally, evidence is accumulating that the progenitors of Type II-narrow SNe may be related to luminous blue variables. However, the nature of the progenitors of Type Ib/c SNe, a subset of which are associated with the amazing gamma-ray bursts, remains ambiguous. Furthermore, we remain in the continually embarrassing situation that we still do not yet know which progenitor systems explode as Type Ia SNe, which are being used for precision cosmology. In Cycles 16, 17, 20, 21, 22, and 23 we have had great success with our approved ToO programs. As of this proposal deadline, we have already triggered on two supernovae (SN 2016adj and SN 2016bkv) with our Cycle 23 program. We therefore propose to continue this project to determine the identities of the progenitors of 4 SNe within, generally, about 20 Mpc, which we expect during Cycle 24, through ToO observations using WFC3/UVIS.

Proposal Category: GO

Scientific Category: Blackholes

ID: 14785

Program Title: Enhanced rates of tidal disruptions in E+A galaxies: resolving the central dynamics of post-starburst galactic nuclei with HST observations

Principal Investigator: Sjoert van Velzen

PI Institution: The Johns Hopkins University

Recent optically selected samples of tidal disruption flares (TDFs) have uncovered an interesting puzzle. In post-starburst galaxies, the observed rate of stellar disruptions is enhanced by 1-2 orders of magnitude. A natural explanation of the enhanced rate is an overdense central stellar cusp, created during the recent starburst. The short relaxation times in these cusps can significantly boost the number of stars that are scattered towards the central supermassive black hole. This scenario has a clear observational signature: a steep surface brightness profile on scale of 1-10 pc. Archival HST/WFC3 imaging of the low-redshift post-starburst galaxy NGC 3156 confirms this signature. Our dynamical analysis of the surface brightness profile suggests this galaxy could be a true TDE factory, with stellar disruptions occurring as often as once per millennium. Clearly, observations of more galaxies are needed to improve the significance of this result. Using a recently compiled catalog of post-starburst galaxies, we have found four galaxies that allow for an improved measurement of the TDE rate compared to work on NGC 3156. We propose multi-band HST/WFC3 imaging of these targets. These observations provide the only method to directly measure the TDE rate from the surface brightness profile of post-starburst galaxies and will therefore critically test the overdensity hypothesis.

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14772

Program Title: Observing gas in Cosmic Web filaments to constrain simulations of cosmic structure formation

Principal Investigator: Bart Wakker

PI Institution: University of Wisconsin - Madison

Cosmological simulations predict that dark matter and baryons condense into multi-Mpc filamentary structures, making up the Cosmic Web. This is outlined by dark matter halos, inside which 10% of baryons are concentrated to make stars in galaxies. The other 90% of the baryons remain gaseous, with about half located outside galaxy halos. They can be traced by Lyman alpha absorbers, whose HI column density is determined by a combination of gas density and the intensity of the extragalactic ionizing background (EGB). About 1000 HST orbits have been expended to map the 50% of baryons in galaxy halos. This contrasts with 37 orbits explicitly allocated to map the other 50% (our Cycle 18 program to observe 17 AGN projected onto a single filament at cz~3500 km/s). We propose a 68-orbit program to observe 40 AGN, creating a sample of 56 sightlines covering a second filament at cz~2500 km/s. Using this dataset we will do the following: (1) measure the intensity of the EGB to within about 50%; (2) confirm that the linewidth of Lya absorbers increases near the filament axis, suggesting increasing temperature or turbulence; (3) check our earlier finding that simulations predict a transverse density HI profile (which scales with the dark-matter profile) that is much broader than is indicated by the observations.

Proposal Category: AR

Scientific Category: IGM and COS

ID: 14588

Program Title: Surveying the CGM of Nearby Galaxies

Principal Investigator: Bart Wakker

PI Institution: University of Wisconsin - Madison

Galaxies evolve through complex interactions with their gaseous environment, the intergalactic medium, by both ejecting enriched material into it and drawing new fuel for star formation from it. Studying these processes observationally is challenging, yet crucial for understanding and effectively modeling global galaxy evolution. Numerous studies have probed this material via Ly-alpha absorption in the spectra of background QSOs, but suffer from issues with incompleteness, sample size, and reproducibility. To overcome these issues we are proposing a large-scale study using 300 archival COS spectra and limiting ourselves to cz < 10,000 km/s, where we can take advantage of highly complete nearby-galaxy catalogs. We aim to understand two key questions: a) how do the properties of Ly-alpha absorbers (e.g. equivalent width, location, velocity) depend on the properties of the galaxies they are associated with (e.g. size, inclination, morphology)? b) do absorbers tend to follow the rotation direction and velocity of the associated galaxies? This proposal aims to take large steps towards answering these questions and providing new constraints on the galaxy-absorber relationship.

Proposal Category: AR

Scientific Category: Stellar Populations

ID: 14589

Program Title: Variability Studies of Stars in the Central 2 arcmin of the Galactic Center

Principal Investigator: Daniel Wang

PI Institution: University of Massachusetts - Amherst

Nuclear clusters are the most massive and densest stellar systems in the local Universe. They can be found in >70% of all galaxies. The nuclear cluster at the centre of the Milky Way appears to be a typical representative of these objects and is the only one which we can actually resolve observationally. However, crowding and extreme extinction pose serious obstacles on our knowledge of its stellar population, especially the old one. Variable stars can provide crucial information on the latter. Existing variability studies of the nuclear cluster suffer from a lack of sensitivity and angular resolution and/or are limited to the central parsec. We propose a groundbreaking variability study of the nuclear star cluster by taking advantage of the large number of archived HST/WFC3 observations at F153M band with a baseline of 4 years. This study will also capitalize on the high sensitivity (50% completeness limit, 21 mag at F153M) and angular resolution (0.2"), as well as the large field coverage (4.8 pc x 4.8 pc) of the data. Our primary goal is to detect RR Lyrae stars, tracing the old, low-metallicity population and providing an important test of the formation scenario of the nuclear cluster through globular cluster infall.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14621

Program Title: Probing the young circumplanetary environment of a directly-imaged exoplanet through a rare transit event

Principal Investigator: Jason Wang

PI Institution: University of California - Berkeley

Among the thousands of known exoplanets, Beta Pic b is the only directly imaged exoplanet with a nearly edge-on orbit that may transit its host star. We show that the latest astrometric measurements rule out a transit by the planet at >10-sigma significance, but we are certain that the Hill sphere of the planet will transit. Unfortunately, Beta Pic will not be visible from the ground during the entire ingress of its Hill sphere. With a period of ~20 years and no other system like it, this Hill sphere transit provides a rare opportunity to study the evolving circumplanetary environment of a young and well-characterized exoplanet. Thus we propose a modest HST campaign to photometrically search for signatures of the planet's large scale circumplanetary material. The existence of such material is plausible given that Beta Pic's young age is similar to that of the ring-bearing J1407b system. Using the exquisite photometric precision offered by WFC3 in spatial scanning mode, the data may detect gaps in a circumplanetary disk, indicative of rings carved out by newly-formed satellites. Given the sparse observational data for circumplanetary environments, non-detections will also be valuable for constraining the timescales relevant to circumplanetary material and moon formation. If photometric variations are detected with HST, these results would have enormous significance to the community since ground-based facilities could subsequently be used to monitor egress at higher cadence.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 14750

Program Title: Exploring environmental effects on galaxy formation with WFC3 in the most distant cluster at z=2.506

Principal Investigator: Tao Wang

PI Institution: CEA/DSM/DAPNIA/Service d'Astrophysique

We have recently discovered a remarkable concentration of massive galaxies at z=2.506 in the COSMOS field, containing 11 very red galaxies within a 10'' radius, defining a 11.6sigma overdensity. The total stellar mass M* ~ 10^{12} Msun found within 80 kpc is consistent with a core of a dark matter halo with total mass M_{200c} ~ 10^{14} Msun, as further confirmed with extended X-ray emission and velocity dispersion (16 spectroscopic members), identifying it as the most distant galaxy cluster known to date. However, unlike other clusters discovered so far the red galaxies in this structure are virtually all star forming with a total star formation rates (SFR) ~3400Msun yr^{-1} in its 80 kpc-wide core, suggesting that it was caught in a rapid formation phase of a dense cluster core. Hence this structure provides a rare chance to witness the build-up of the cluster central galaxies, and explore environmental effects on massive galaxy evolution in the densest environment. Here we propose WFC3 F125W and F160W imaging (rest-frame U and B band, respectively) of this structure to push the study of mass-size relation and SFR-morphology relation for cluster galaxies to the highest redshift. These observations of this unique structure will provide crucial insights on the interplay between morphological transformation and star formation quenching in cluster cores.

Proposal Category: AR

Scientific Category: ExoPlanets

ID: 14590

Program Title: Enhancing the Scientific Return from HST Imaging of Debris Disks

Principal Investigator: Alycia Weinberger

PI Institution: Carnegie Institution of Washington

We propose realistic modeling of scattering of light by small aggregate dust grains that will enable us to interpret visible to near-infrared imaging of debris disks. We will determine if disk colors, phase functions, and polarizations place unique constraints on the composition of debris dust. Ongoing collisions of planetesimals generate dust; therefore, the dust provides unique information on compositions of the parent bodies. These exosolar analogs of asteroids and comets can bear clues to the history of a planetary system including migration and thermal processing. Because directly imaged debris disks are cold, they have no solid state emission features. Grain scattering properties as a function of wavelength are our only tool to reveal their compositions. Solar system interplanetary dust particles are fluffy aggregates, but most previous work on debris disk composition relied on Mie theory, i.e. assumed compact spherical grains. Mie calculations do not reproduce the observed colors and phase functions observed from debris disks. The few more complex calculations that exist do not explore the range of compositions and sizes relevant to debris disk dust. In particular, we expect porosity to help distinguish between cometary-like parent bodies, which are fluffy due to high volatile content and low collisional velocities, and asteroidal-like parent bodies that are compacted.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14622

Program Title: A Chance Alignment: Resolving a Massive Compact Galaxy Actively Quenching at z=1.8

Principal Investigator: Katherine Whitaker

PI Institution: University of Massachusetts - Amherst

Using HST imaging from the Sloan Giant Arcs Survey, we have identified a strongly-lensed massive (log M/Msun = 10.4) red galaxy at z=1.8 that is remarkably compact (r~0.7 kpc). This galaxy, 0851-E, is already structurally similar to quiescent, massive galaxies and appears to be in the process of quenching, with a gas fraction <10%. Using WFC3/G141 grism spectroscopy, we propose to measure age gradients and emission line diagnostics ([OIII]/Hbeta) in the inner 1 kpc and in the outskirts. This spatially resolved study will enable us to distinguish between physical mechanisms that are hypothesized to form and quench star-formation in massive galaxies, leading to the eventual buildup of the red sequence. Resolved spectroscopic studies of compact galaxies are only possible due to the lensing magnification and distortion, which boosts HST's already excellent spatial resolution; these observations will develop necessary analysis tools for the JWST era. This novel HST program will be the first study to spatially resolve the stellar populations and emission line diagnostics of a compact star-forming galaxy that is "running on empty". We will provide strong constraints on the physical mechanisms driving a short-lived but key phase of massive galaxy formation.

Proposal Category: GO

Scientific Category: Stellar Physics

ID: 14786

Program Title: Progenitor Masses for Every Nearby Historic Core-Collapse Supernova

Principal Investigator: Benjamin Williams

PI Institution: University of Washington

Some of the most energetic explosions in the Universe are the core-collapse supernovae (CCSNe) that arise from the death of massive stars. They herald the birth of neutron stars and black holes, are prodigious emitters of neutrinos and gravitational waves, influence galactic hydrodynamics, trigger further star formation, and are a major site for nucleosynthesis, yet even the most basic elements of CCSN theory are poorly constrained by observations. Specifically, there are too few observations to constrain the progenitor mass distribution and fewer observations still to constrain the mapping between progenitor mass and explosion type (e.g. IIP IIL, IIb, Ib/c, etc.). Combining previous measurements with 9 proposed HST pointings covering 13 historic CCSNe, we plan to obtain progenitor mass measurements for all cataloged historic CCSNe within 8 Mpc, optimizing observational mass constraints for CCSN theory.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category:	AR
Scientific Category:	Galaxies
ID:	14591
Program Title:	Project ALCATRAZ: Archival Lyman-Continuum and Theoretical Reionization Analysis vs. z: Where, When, & How Much Does LyC Escape from Galaxies & AGN?
Principal Investigator:	Rogier Windhorst
PI Institution:	Arizona State University

Project ALCATRAZ will study Lyman continuum (LyC) radiation escaping from galaxies and weak AGN at z=2.3 -4, vastly expanding our systematic study of the Early Release Science (ERS) field to include Archival UV images in HUDF and GOODS/CANDELS. Each field was imaged in 2-3 WFC3 UV-filters and 6-9 ACS + WFC3/IR filters. SED-fits for objects with secure spectroscopic redshifts will provide luminosity, stellar mass, age, SFR, extinction, and escape fraction estimates.

With very careful attention to systematics, stacking 6-15 orbit native depth for many 100s of objects will reach UV-depths of 100s-1000s of orbits. ALCATRAZ will reveal where, when, how, and how much LyC escapes, and if galaxies started and AGN maintained cosmic reionization. Its science goals are:

1. HOW MUCH LyC escapes? First results from separately stacking 50 galaxies and 14 weak AGN at z=2.3-4 suggest m(LyC) ~ 29-30.5 mag (>3-4 sigma). With robust 8-12 filter SEDs, HST rejection of foreground interlopers, and 115 new ground-based spectra, ALCATRAZ will increase current statistics 7x and depth 2.7x.

2. WHERE and HOW does LyC escape? HST stacking will measure LyC light-profiles at radii r<0.7", which are likely shallow if LyC escapes through an ISM that gets more porous at larger radii, which we will constrain.

3. WHEN did LyC escape? We will constrain how LyC escape fractions evolved with epoch for galaxies & weak AGN, and if this followed the cosmic star-formation rate.

Proposal Category: GO

Scientific Category: Solar System

ID: 14661

Program Title: Wide Field Coverage for Juno (WFCJ): Jupiter's 2D Wind Field and Cloud Structure

Principal Investigator: Michael Wong

PI Institution: University of California - Berkeley

Juno will take novel measurements in the jovian system during HST Cycles 23, 24, and 25. This proposal supports Juno's neutral atmospheric investigation, which includes measurements with an IR imager/spectrometer (JIRAM) and the Microwave Radiometer (MWR). Both will achieve high spatial resolution as the orbiter swoops past Jupiter, in between the radiation belts and the cloud tops. But instrument fields of view are small compared to the planet, so HST observations would provide valuable context and complementary information.

We propose to measure Jupiter's 2D wind field, as well as UV/optical cloud colors (and their evolution). We will measure winds using sets of global maps that cover two of Juno's perijove passes, characterizing the time-varying dynamics of waves, jets, vortices, and storms. The remaining perijove passes will be covered by snapshot (1-orbit) visits, sufficient to characterize feature morphology along each Juno track at high resolution. These observations will give crucial context for MWR observations and enable more precise retrievals from MWR data.

Earth-based support is particularly important for Juno, due to its highly eccentric orbit and specialized instrumentation. WFC3/UVIS imaging can play an important role in the effort, since no other facility can obtain precise 2D wind fields and UV/optical photometry at high spatial resolution. Without the HST component of

Proposal Category: GO

Scientific Category: IGM and COS

ID: 14809

Program Title: An Accurate Measurement of the IGM HeII Lyman Alpha Forest toward a Newly Discovered UV-bright Quasar at z>3.5

Principal Investigator: Gabor Worseck

PI Institution: Max-Planck-Institut fur Astronomie, Heidelberg

The advent of GALEX and COS have revolutionized our view of HeII reionization, the final major phase transition of the intergalactic medium. COS spectra of the HeII Lyman alpha forest have confirmed with high confidence the high HeII transmission that signifies the completion of HeII reionization at z~2.7. However, the handful of z>3.5 quasars observed to date show a set of HeII transmission 'spikes' and larger regions with non-zero transmission that suggest HeII reionization was well underway by z=4. This is in striking conflict with predictions from state-of-the-art radiative transfer simulations of a HeII reionization driven by bright quasars. Explaining these measurements may require either faint quasars or more exotic sources of hard photons at z>4, with concomitant implications for HI reionization. We propose here to observe J2354-2033, an FUV-bright quasar at z=3.786 that we recently discovered in a dedicated survey for likely HeII-transmitting quasars. With this COS/G140L spectrum, we would confirm that the quasar is valuable for studies of the HeII Lyman alpha forest by identifying possible interloping low-z HI absorbers, provide accurate measurements of the IGM HeII opacity, and provide only the third z>3.5 sightline that would allow for high-resolution G130M spectroscopy before the end of HST's mission. The proposed observations would mark only the fourth observation of the HeII Lyman alpha forest at z>3.7 and the source would be the 2nd-brightest known on the sky at these redshifts.

Proposal Category: GO

Scientific Category: ExoPlanets

ID: 14646

Program Title: A White Dwarf with an Actively Disintegrating Asteroid

Principal Investigator: Siyi Xu

PI Institution: European Southern Observatory - Germany

We have recently discovered a white dwarf with an actively disintegrating asteroid. Using data from the Kepler extended mission, transits with periods less than 5 hours have been detected from at least 6 objects. Evidence for circumstellar dust was found by comparing UKIDSS and WISE data. High-resolution optical spectroscopic data from Keck show that the host star is heavily polluted with 11 heavy elements and also displays numerous absorption lines from circumstellar gas. This system has become much more active since its original discovery. We were granted mid-cycle observing time with Hubble and a few other telescopes to perform simultaneous observations. Our preliminary analysis already shows new emerging features. We propose to monitor this system two more times for the next year and study the real time disintegration of an asteroid around a white dwarf.

Proposal Category: GO

Scientific Category: Galaxies

ID: 14751

Program Title: Resolving Fe-rich Neutral ISM in a Massive Quiescent Galaxy at z~0.4

Principal Investigator: Fakhri Zahedy

PI Institution: University of Chicago

Roughly 40% of elliptical galaxies are found to contain cool gas but exhibit no on-going star formation, indicating that some feedback mechanisms are at work. While AGN feedback is commonly thought to be responsible for quenching star formation in massive halos, recent work has reiterated the importance of feedback from old stellar populations, including Type Ia supernovae (SNe Ia). In Zahedy et al. (2016), we reported detections of ultra-strong MgII absorption (>3.6 Ang) at 1-2 effective radii of a massive quiescent lensing galaxy at z=0.408. Strong MgII, FeII, MgI, and CaII absorption are found at the lens redshift along two lensed QSO sightlines separated by ~8 kpc. The absorbers are resolved into 15 components with line-of-sight velocity spread of ~600 km/s. The large observed ionic column densities, N>1e14 cm^-2 suggest large neutral hydrogen column densities N(HI)>1e18 cm^-2 and a significant neutral gas fraction. The most striking feature is the uniformly large Fe/Mg ratio across the full 600 km/s velocity range, suggesting a large contribution in chemical enrichment from SNe Ia (>20%). Here we propose QSO absorption-line spectroscopy of this unique system using STIS and the G140L grating with the slit oriented along the two lensed QSOs. The goal is to determine N(HI) from observations of the full Lyman absorption series and gas-phase metallicity of the interstellar medium at two locations separated by ~8 kpc in an elliptical galaxy beyond the local universe. With a modest investment of HST time, we will be able to examine the extent SNe Ia-driven feedback in a distant quiescent galaxy using this unique double-lens system.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Galaxies

ID: 14592

Program Title: From molecular to coronal lines: a COS survey of multi-phase galactic outflows

Principal Investigator: Nadia Zakamska

PI Institution: The Johns Hopkins University

Galactic winds powered by supernovae or active galactic nuclei (AGN) are a major component of galaxy formation and are thought to drive the metallicity evolution and the stellar mass evolution of the universe. They are composed of gas at an extremely wide range of physical conditions, which presents a major theoretical and observational obstacle; as a result, the balance of energy and mass outflow rates between different phases is not known. We will systematically analyze the entire COS archive to identify absorption features probing all phases of the outflow, from hot to molecular phase. We will conduct the first systematic search of diffuse molecular gas probed by the Lyman-Werner absorption bands. We will determine the outflow contribution by kinematic analysis and we will analyze the relationship between the kinematics of different phases. We will study outflows, their kinematics and their multi-phase structure as a function of galaxy type and outflow type (starburst-driven vs AGN-driven) and a variety of galactic parameters such as stellar mass and star formation rates. We will directly compare our observations with FIRE numerical simulations of galactic winds. Our analysis will provide the first comprehensive view of the diffuse molecular phase of the outflows and will address a long-standing problem of measuring the energetics of the different components of galactic winds.

Cycle 24 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Blackholes

ID: 14608

Program Title: Host galaxies of high-redshift quasars with extreme outflows

Principal Investigator: Nadia Zakamska

PI Institution: The Johns Hopkins University

Feedback from accreting supermassive black holes is now a standard ingredient in galaxy formation models. It has long been speculated that powerful quasars, triggered in major gas-rich mergers, had a profound impact on galaxy formation via quasar-driven winds. This process must have been at its peak during the epoch of most active galaxy formation and quasar activity at z=2-3, yet there is not yet any direct observational support for this long-hypothesized process. We have discovered a population of extremely luminous (L>1e47 erg/s) red quasars with peculiar line properties at z=2-3 which show unprecedented signatures of powerful v>2000 km/s outflows in their [OIII]5007A lines. We propose to image eleven of these objects with the HST in two filters, one probing rest-frame UV and one probing the rest-frame optical. The rest-frame optical observations will directly probe the dynamical state and extent of the hosts of luminous obscured quasars and search for companions and merger signatures. We will determine the masses of the stellar component to determine if the bulges of the quasar hosts have already become apparent in this epoch. Using the rest-frame UV observations, we will probe the distribution of the gas in quasar hosts by observing the morphology of ongoing star formation and scattered light from the central engine. Our targets are the best candidates to probe the long-speculated merger-driven scenario for quasar activity, and our proposed HST observations will definitively determine whether this process drives the evolution of massive galaxies.