Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Solar System Astronomy

ID: 16192

Program Title: Re-activation of binary main-belt comet 288P

Principal Investigator: Jessica Agarwal

PI Institution: Max Planck Institute for Solar System Research

We propose to closely follow the expected re-activation of the unusual binary main-belt comet 288P (300163) in the fall of 2021, to identify the active component(s). This is a crucial parameter to understand the formation and evolution of this system which is unique among the known binary asteroids both because of its comet-like activity and because of its wide, eccentric and asynchronous mutual orbit in combination with similarly sized components. We request a total of 8 orbits. Seven orbits, distributed across one month, will serve to measure the brightness increase due to dust as the system re-approaches perihelion in 2021. In addition, we request 1 orbit in 2021 June to probe for a potential orbit instability. It is currently unclear why no other systems with similar orbital properties as 288P are known. There is a strong detection bias against such systems, and the binary nature of 288P was only identified because of its activity. One the other hand, if activity is needed to form such systems, they may indeed be rare. Our proposed observations will shed light on the frequency of similar systems and on the processes behind binary asteroid formation and evolution. Since the re-activation is expected for the 2021 September-October time frame, we request 4 orbits in Cycle 28 and 4 orbits in Cycle 29.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16207

Program Title: Photochemistry in TESS's first habitable zone terrestrial planet, TOI-700 d

Principal Investigator: Giada Arney

PI Institution: NASA Goddard Space Flight Center

Recently, the TESS spacecraft uncovered an exciting three-planet system that included its first habitable zone terrestrial planet, TOI-700 d. This system orbits an M2V dwarf located 31 pc away from Earth. Previous studies of the TOI-700 system have not included photochemistry, but photochemistry can strongly impact planetary atmospheric composition, habitability, and observable spectral features. A critical input for accurate photochemical modeling of this system is the UV spectrum of the host star, TOI-700. Measured UV spectra of exoplanet host stars have been heavily used for a diverse range of modeling efforts and are a critical in-demand need of the exoplanet community. We will measure the UV spectrum of TOI-700 (1150-5000 A), use it to update previous modeling efforts of possible atmospheres and spectra of TOI-700 d, and make the spectrum available to the community. This will result in the first self-consistent model atmospheres for TOI -700 d using a 3-D climate model with clouds and atmospheric dynamics coupled to a photochemical and spectral model. We will be able to put this new analysis into the context of previous works considering climatically and photochemically self-consistent atmospheres and spectra of potentially habitable M dwarf planets. TOI-700 will be the earliest M dwarf for which such a study has been performed for a specific known planet and will thus provide a useful point of comparison against potentially habitable worlds around later M dwarfs, including TRAPPIST-1 (M8V). The stellar UV spectrum we measure will also be able to be used in future works considering the atmospheres and spectral features of all planets in the TOI-700 system.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16161 |
| Program Title: | Measuring Cosmic Ray Acceleration in a Young Supernova Remnant in the Large Magellanic Cloud: The Case for a Third Epoch Observation of SNR0519 -69.0 |
| Principal Investigator: | Prasiddha Arunachalam |
| PI Institution: | Rutgers the State University of New Jersey |

Supernova shocks have been long-favored as sites for accelerating cosmic rays (CR). They have been studied extensively in multiple wavebands to look for signatures of accelerated particles in the strong amplified magnetic fields created at shock fronts. In this proposal, we present an optical-only study of CR acceleration, by examining a specific class of astrophysical shocks known as 'Balmer shocks'. Our target is supernova remnant (SNR) 0519-69.0 in the Large Magellanic Cloud (LMC) that has strong Balmer emission. We propose a third ACS/WFC observation of this SNR, which will provide a ~10 year baseline to measure the proper motion of the remnant. The well known distance to the LMC allows one to convert the proper motions to accurate shock velocities. The shock velocities, combined with ground-based spectroscopic measurements of the broad H alpha line-widths will be used to calculate the CR acceleration efficiency over a broad range of shock velocities using state-of-the-art models. We demonstrate the significant reduction in shock velocity uncertainties resulting from increasing the time baseline from the current 1 year to 10 years. We highlight the importance of matching the observational configuration to minimize systematic errors in the proper motion. With the new observation, we aim to reveal the dependence of CR acceleration efficiency on shock velocity.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Intergalactic Medium and the Circumgalactic

ID: 16219

Program Title: Exploring the origin of the M31-M33 filament

Principal Investigator: Kat Barger

PI Institution: Texas Christian University

Between M31 and M33 lies a debris field of HI clouds. These clouds may represent a tidal remnant from a past interaction between M31 and a satellite galaxy, a population of satellite galaxies, halo gas condensations, cooling gas along an intergalactic medium filament, or M31 stellar or weak AGN feedback. We request HST/COS UV absorption-line and coordinated GBT HI emission-line observations along 2 UV bright background QSO sightlines to conduct a detailed investigation of the chemical composition, dust depletion patterns, and kinematics of the M31-M33 clouds to constrain their origin. Using the requested observations, along with archival observations, we will further measure their ionization properties to determine the relative influence of the surrounding coronal gas and the incident radiation field has on them. Combined, this will enable us to assess where this gas came from, how much material it contains in neutral and ionized gas, and whether this stream could survive a journey to M31. This study will provide insight on how L* galaxies replenish their gas reservoirs by measuring the physical properties of material that is inflowing onto M31 in absorption- and emission-line spectroscopy out to 1/3 of a virial radius.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16220

Program Title: An Observational Anchor for Brown Dwarf Models

Principal Investigator: Thomas Beatty

PI Institution: University of Arizona

We wish to use 5 orbits of HST/WFC3 time to observe an eclipse spectrum of the only known transiting brown dwarf that has all of its physical properties independently measured at high precision, and that receives a negligible amount of external irradiation. Brown dwarfs evolve in both radius and temperature as they age, changing their atmospheric spectral emission with time. Understanding this evolution is important because it informs us about their interior structure, which ultimately helps constrain where the dividing line is between brown dwarfs that form through "star-like" Jeans-collapse or "planet-like" accretion. However, a fundamental problem in brown dwarf evolution and atmosphere models has been our inability to directly measure their basic physical properties, and no one has yet observed the atmosphere of a non-irradiated brown dwarf where we know all of them. The discovery of our target system finally allows us to conduct just this sort of observation using HST/WFC3 -- in conjuntion with archival Spitzer eclipse observations at 3.6um and 4.5um. Measuring the emission spectrum will allow us to perform a set of tests on brown dwarf evolution and atmospheres models with an an over-constrained physical system with no major free parameters. The results will provide a one-of-a-kind observational anchor for brown dwarfs.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16236

Program Title: The Life and Death of Ultra-Hot Jupiter WASP-12b

Principal Investigator: Taylor Bell

PI Institution: McGill University

A new class of exoplanets called ultra-hot Jupiters has recently been recognized; these gas-giant exoplanets are on extremely close orbits around their host stars and have dayside atmospheres which reach >2500 K. Ultra-hot Jupiters are so strongly irradiated that many of the molecules, including the dominant constituent hydrogen, will thermally dissociate on their daysides and may recombine on their cooler nightsides. Significant mass loss and tidal distortion have also been predicted for some ultra-hot Jupiters. However, there are currently few ultra-hot Jupiters whose entire atmospheres are well characterized, and additional high precision observations are required to test recent model predictions. We therefore propose to collect one HST/WFC3 G141 spectroscopic full-orbit phasecurve of WASP-12b - the prototypical ultra-hot Jupiter - in order to create longitudinally resolved temperature and chemical maps, to understand the enormous ellipsoidal variations seen at 4.5 microns, and to better constrain the planet's orbital decay rate and the stellar tidal quality factor.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16303

Program Title: Fine-Tuned Search for Kilonova Emission in a Short Gamma-Ray Burst: Implications for the Progenitors, GW Sources, and r-Process Nucleosynthesis

Principal Investigator: Edo Berger

PI Institution: Harvard University

The joint gravitational wave and electromagnetic detections of the binary neutron star (BNS) merger GW170817 ushered in a new era of astrophysics. In the UV/optical/NIR the emission (a "kilonova") was powered by radioactive decay of nuclei produced via r-process nucleosynthesis. In the gamma-ray, X-ray, and radio the emission was instead powered by an off-axis jet typical of short gamma-ray bursts (SGRBs); this connection was previously supported by the HST detection of a kilonova in the short GRB130603B. With only a single joint GW-EM detection and a single kilonova detection in an SGRB, the key frontier is to begin to map the distribution of merger outcomes: ejecta mass, velocity, geometry, and nucleosynthetic yields. Here we propose to achieve this goal with HST observations of a kilonova associated with an SGRBs; observations of kilonovae in SGRBs are essential because the orientation is well known (face-on, along the binary's angular momentum axis) and the LIGO/Virgo Observing Run 3 has not yielded joint GW-EM detections. Such a study can only be achieved with the sensitivity and resolution of HST, and it matches one of the "special initiatives", namely deep NIR monitoring that is essential for informing future JWST follow-ups ("JWST Preparatory Observations"). We request 10 orbits for 1 SGRB event. The HST observations will be supported by approved programs at Chandra, VLA, ALMA, Gemini, Keck, Magellan, MMT that will provide the targets, cover optical and early NIR follow-up to establish the baseline behavior, and complete the multi-wavelength picture of the event. Given the broad interest in this topic we waive the proprietary period.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Solar System Astronomy

ID: 16119

Program Title: Atmospheric Evolution of Uranus

Principal Investigator: Dolon Bhattacharyya

PI Institution: University of Illinois at Urbana - Champaign

This archival research program will be to reduce, analyze and model Lyman alpha emissions from the exosphere of Uranus conducted between 1996 to 2017. The goal is to study the evolution of Uranus' exosphere as it traversed in its orbit around the Sun. An initial reduction of the 1998 data shows Lyman alpha emission up to 5 Uranus radii (127795 km). Uranus' thermospheric temperature has been observed to decrease with time since 1990. The effect of this steady cooling on its exospheric density distribution and escape will be determined using the archived HST observations. This will allow for a better understanding of the dust environment, essential for planning future Ice Giant missions. At present, there is no general understanding of Uranus' exosphere and its evolution with seasons as no studies have been conducted after the intial Voyager 2 visit. The archived set of observations as well as the existence of an in-house radiative transfer model which can simulate optically thick Lyman alpha emissions from planetary H exospheres, provides the perfect opportunity to bridge this knowledge gap. Under the proposed program, data from HRS, STIS and ACS will be used and an updated calibration factor for ACS at Lyman alpha and a STIS Lyman alpha flatfield will be applid to the data reduction process. The radiative transfer model will then be used to simulate the Lyman alpha emissions from Uranus' exosphere in order to determine its characteristics.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Solar System Astronomy |
| ID: | 16193 |
| Program Title: | Building connections: Juno and STIS contemporaneous observations of Jupiter's magnetosphere and auroras |


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| Principal Investigator: | Bertrand | Bonfond |
| PI Institution: | Universite de Liege | |



Juno and HST form a powerful and unique combination to unravel the processes coupling the Jovian magnetosphere to its atmosphere through its auroras. As an example, context images of the UV auroras offered by HST help making sense out of the Juno in situ measurements and disentangle spatial from temporal effects. As Juno's orbit evolves, new challenges and opportunities emerge during cycle 28. In particular, Juno will fly at lower and lower altitudes over the north pole, potentially accessing the deepest part of the region where the charged particle causing the aurora get accelerated. Unfortunately, Juno's remote sensing instruments will be too close to Jupiter and Juno will fly to fast in the North to offer global images of the auroras associated with the in situ wave, field and particle measurements. Only HST is able to provide the spatially resolved UV images critical to properly interpret the data. Furthermore, Juno will cross the magnetic equator closer and closer to Jupiter, exploring new areas where some key physics for the dynamics of the plasma in Jupiter's magnetosphere takes place. Simultaneous global images with the STIS instrument will allow the identification and classification of the structures crossed by Juno as well as estimates of their spatial range and temporal variability. In return, Juno will unravel the plasma processes giving rise to the auroral feature imaged by HST. Finally, we will take advantage of a rare opportunity for truly simultaneous imaging of the two polar auroras of Jupiter when Juno is in the southern hemisphere to shed light on the mystery of the conjugate auroral flares in the polar-most region of the Jovian auroras.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Galaxies |
| ID: | 16227 |
| Program Title: | Extremely Metal Poor Galaxies (XMPGs): A Search for the Lowest Metallicity Gas in Nearby Galaxies |


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| Principal Investigator: | David | Bowen |
| PI Institution: | Princeton University | |



We propose a COS G130M program to measure the gas-phase metallicities of the cool neutral medium in 5 "extremely metal poor galaxies", or XMPGs. We have selected the XMPGs to have emission line metallicities, Z_emm, in the range 12+log(O/H) = 7.1 to 7.5, or 1/40th to 1/16 times the solar metallicity. The COS spectra of the UV-bright regions in the galaxies will record, in particular, Lyman-alpha, SII, PII, NI, CII and OI absorption lines, which can be used to derive accurate column densities and therefore abundances and abundance ratios. We aim to test how much less the metallicity of the neutral medium, Z_abs, can be, compared to Z_emm, a difference that is seen in higher metallicity star-forming galaxies. We also aim to provide accurate N/O and alpha/O abundance ratios in the XMPGs' neutral gas from which to investigate their star formation histories. Two unique galaxies are targeted, DDO 68, which is one of the lowest metallicity galaxies known, and SBS 0940+544, a galaxy where Z_emm drops by a dex over a transverse length of only 400 pc. Confirming differences in Z_abs and Z_emm in XMPGs will show that the baseline metallicity for the canonical stellar-mass to metallicity relationship should use Z_abs instead of Z_emm in galaxy evolution modelling. We will also use our data to explore whether XMPGs could be the progenitors of young galaxies seen by the damped Lyman-alpha absorption systems detected towards background QSOs, or whether the origin of the latter population still needs to be properly explained.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16162 |
| Program Title: | Solving the metallicity dependence of evolved star evolution and completing HST's near-IR legacy in the Local Volume |


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| Principal Investigator: | Martha | Boyer |
| PI Institution: | Space Telescope Science Institute | |



Thermally-pulsing (TP-)AGB stars and red helium-burning (RHeB) stars dominate the near-infrared (NIR) flux in star-forming galaxies (up to 70%) and thus have a strong impact on the appearance of galaxies. These stars are notoriously difficult to model, and the only empirical constraints on their evolution come from the Magellanic Clouds, at just 20% and 50% solar metallicity. Lower metallicity models are entirely uncalibrated and these uncertainties propagate to stellar population synthesis, leading to (sometimes wildly) inaccurate derived galaxy properties such as the star-formation rate and stellar mass. The HST is capable of rectifying this. By adding NIR and some additional optical imaging to existing optical and UV imaging of an optimally selected sample of nearby (< 3.1 Mpc) metal-poor dwarf galaxies, we can produce observables (luminosity functions, stellar counts, CMD morphology, stellar SEDs) that stringently constrain the metallicity dependencies on the processes that drive model uncertainties, including mass loss, dredge up, convective overshoot, and rotation. Understanding the metallicity dependence of these parameters is invaluable to interpreting observations of metal-poor galaxies, which dominate the number density of galaxies in the Universe. Given the prior HST investment of observations in these galaxies, this relatively modest amount of observing time promises to revolutionize the field and leave a lasting HST legacy in the Local Volume.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16190

Program Title: Ultraviolet Spectroscopy of Extreme Standard Candles

Principal Investigator: Peter Brown

PI Institution: Texas A & M University

Despite their widespread use as standard candles to measure cosmological distances, Type Ia supernovae are not a homogeneous group of explosions. There are variations in optical light curve shape and ejecta velocity, for example. The sensitivity of the UV to differences in progenitor systems, explosion physics, and environmental conditions makes it a vital regime to determine the physical cause and magnitude of the differences and their effect on the optical bands currently used for cosmological measurements. The goal of understanding the range of progenitor and explosion properties of SNe Ia can be advanced by obtaining UV spectra covering the range of Type Ia supernova properties. The proposed observations will sparsely sample the multi-dimensional parameter spaces of the observed and physical differences between various classes. The goal is to bring order to these disparate objects by determining which are actually physically related and by what parameters. Combined with previous HST observations, these observations will form the definitive observational sample for building theoretical models, constraining progenitor environments, and comparing with high-redshift supernovae from past and future observatories including LSST and WFIRST.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Large Scale Structure of the Universe

ID: 16221

Program Title: Red or Reddened Supernovae? Understanding the Ultraviolet Differences of Normal Standard Candles

Principal Investigator: Peter Brown

PI Institution: Texas A & M University

Constraining systematic uncertainties is critical to accurately and confidently use type Ia supernovae as precise cosmological distance indicators. The two dominant astrophysical systematics in optical-based studies are dust reddening and intrinsic color differences. Swift ultraviolet observations of even the most normal type Ia supernovae show a large dispersion in colors, consistent with contributions from both intrinsic differences and dust reddening. The four sets of high-quality ultraviolet spectra with the Hubble Space Telescope do not yet fully sample this distribution, but comparisons among them reveal a complexity which requires the contribution of multiple effects. We request a series of ultraviolet spectroscopy of two more type Ia supernovae. These will be chosen based on early Swift photometry to be of the undersampled red variety, allowing us to measure the wavelength dependence of the intrinsic color and/or host galaxy reddening by comparison with the existing samples. We will determine the source of the differences and constrain the effect they have on the optical measurements used in cosmological measurements. The spectra will also be a significant fraction of the local comparison sample against which we can compare the rest-frame ultraviolet spectra of higher redshift type Ia supernovae.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16177

Program Title: Digging into the mystery of the Galactic globular clusters M22 and NGC1851

Principal Investigator: Annalisa Calamida

PI Institution: Space Telescope Science Institute

We propose to collect deep near-infrared (NIR) images of two peculiar Galactic globular clusters (GGCs), NGC1851 and M22, to explore the properties of their multiple stellar populations. These GGCs display multiple sequences along the red-giant and sub-giant branches in ultraviolet-optical color-magnitude diagrams (CMDs), and spectroscopy confirmed they host multiple stellar populations with different light- and heavy-element abundances and total content of CNO. How these populations originated is still a mystery. We plan to solve this puzzle by using NIR photometry of low-mass main-sequence (MS) stars: these are brighter in the NIR regime, and the lower part of the MS is more sensitive to heavy and light-element abundances in NIR compared to optical colors. We plan to compare the observed NIR CMDs to theoretical models that include new bolometric corrections taking into account different chemical patterns to characterize the chemical composition and population ratio of the different sub-populations in the GGCs. The presence of chemical inhomogeneities in MS stars similar to those found in the giant stars through spectroscopy will confirm their primordial origin. Furthermore, we will derive the mass function of each stellar sub-population and investigate for the presence of differences. The new NIR data will be combined with archival HST data to derive accurate proper motions for MS stars and to characterize the kinematical properties of the different sub-populations. This analysis will shed light on the origin of multiple populations in these very peculiar GGCs. This work is preparatory for studies with JWST that will allow us to apply the same technique to farther GGCs.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16163

Program Title: Planetary mass loss and the high-energy spectrum of V1298 Tau

Principal Investigator: Paul Cauley

PI Institution: University of Colorado at Boulder

The origin of the radius distribution gap for short-period Kepler planets has become a priority investigation in exoplanet science. The current leading explanation is the photoevaporation of H/He envelopes during the first 100 million years of a planet's lifetime, where the gap is created when planets below some initial envelope mass fraction lose their atmospheres entirely. The star's high-energy spectrum is the main driver of atmospheric loss in short-period planets. Spectral information on the X-ray, EUV, and FUV flux is crucial for accurate modeling of the photoevaporation process in specific systems. The recently-discovered multi-transiting planet system V1298 Tau offers a unique opportunity to investigate atmospheric evaporation in young systems. V1298 Tau is a ~24 million year old star with multiple gas giants in short period orbits. Furthermore, the brightness of V1298 Tau and the transiting nature of it's close-in planets make this system ripe for atmospheric characterization via transmission spectroscopy. We propose to use HST observations to characterize the FUV and NUV flux of V1298 Tau which, combined with scheduled NICER X-ray observations, will allow us to perform a differential emission analysis and approximate the EUV spectrum. We will also perform transit observations to search for absorption by metals in escaping planetary material of the innermost planet and estimate its mass loss rate. Our observations of this incredible star will provide a high-energy spectrum for one of the few <100 Myr old systems with a transiting short-period planet that is amenable to mass loss measurements with current facilities.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16164

Program Title: Measuring mass loss via metal lines from the very young planet AU Mic b

Principal Investigator: Paul Cauley

PI Institution: University of Colorado at Boulder

The known populations of super-Earths and sub-Neptunes with orbital periods less than ~100 days have been shaped by atmospheric evaporation, leading to the observed Radius Valley near 1.7 Earth radii. However, it is currently unclear what the dominant mass loss mechanism is for these planets. The two likely culprits are photoevaporation by the host star's high energy radiation and core-powered evaporation, where the latent heat of formation in the planet's core causes the atmosphere to expand and escape. Distinguishing between these two mass loss mechanisms will require much more precise exoplanet radii statistics or, alternatively, measurements of mass loss for planets of varying ages and incident high energy flux. We propose to address this critical question by using COS to observe the transit of the ~20 million year old planet AU Mic b and measure its mass loss rate in UV metal lines of carbon, silicon, and oxygen. AU Mic is the brightest pre-main sequence star known to host a transiting planet and offers a unique opportunity to detect the planet's atmosphere at very high signal-to-noise in a number of UV mass loss indicators. Furthermore, information from the UV metal lines is complementary to absorption in the hydrogen Lyman-alpha line, which is heavily attenuated by the ISM. The metal lines trace material from the base of the thermosphere, whereas Lyman-alpha samples the highly extended unbound exosphere. Measurements of young planet evaporation rates are vital benchmarks for atmospheric evolution models and AU Mic b is currently the best known exoplanet to perform such an experiment.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Large Scale Structure of the Universe

ID: 16237

Program Title: A massive protocluster at z=7 selected by the South Pole Telescope

Principal Investigator: Scott Chapman

PI Institution: Eureka Scientific Inc.

We request deep near-infrared imaging of an SPT-selected protocluster, SPT0311-62 located at z=6.9. It possesses a very large ~10^13 Msun halo mass for any structure at z>4, immense at z~7. Selected via millimeter-wavelength dust emission in the 2500 square degree South Pole Telescope (SPT) survey, it has been resolved by ALMA into 11 gas-rich galaxies, the 6 brightest /most massive confirmed spectrally to lie in an extended protocluster. Sensitive observations of carbon monoxide and ionized carbon with ALMA, allow assessment of the obscured star formation and gas masses of bright cluster members. The goal of this proposal is to obtain F160W, F125W, F814W HST imaging (3 tiled pointings in WFC3, 1 pointing ACS) to measure the stellar properties, galaxy morphologies, and assess the spatial extent of these structures. The proposed HST observations will provide the imaging and photometric information required for a complete picture of the obscured and unobscured stellar components of the ALMA galaxies, and the expected overdensity of LBGs, revealing the complicated structure in the gas-rich galaxies that host rapid star formation and the less luminous galaxies which trace the filaments of an early collapsing structure. The combination of high resolution ALMA datasets with the proposed HST observations will allow a full characterization of the stars, gas, and dust in this cosmologically important protocluster of primordial starburst galaxies, well into the epoch of reionization in the Universe. From an outreach perspective, the high spatial resolution of the HST identifications of protocluster galaxies will complement the ALMA data in publicizing these high impact results.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16281

Program Title: High-redshift 3CR: witnessing the formation of the most massive galaxies, clusters and AGN in the Bright Ages

Principal Investigator: Marco Chiaberge

PI Institution: Space Telescope Science Institute - ESA

At redshifts between 1 and 2, massive elliptical galaxies are assembling and black holes (BHs) are in the final stages of merging: the AGN phenomenon is about 1000 times more common and star formation is vastly more vigorous than it is now. As the Universe evolves through this enormous transition, important questions arise concerning the causal relationships and interplay between these powerful physical phenomena. Does the AGN fundamentally influence its environment, triggering or quenching star formation on a galactic or galaxy-cluster scale? Do the physical processes of this transition result in the fundamental relationships seen in galaxies today? We propose a complete two-filter WFC3 survey of the 3CR radio source host galaxies at z>1. These are the most powerful radio-loud AGNs that exist at such redshifts, hosted by the progenitors of some of the most massive ellipticals. HST is the only great observatory that has not achieved complete coverage of this landmark sample of quasars and radio galaxies, yet statistical completeness is essential. We will reveal with unprecedented clarity the star formation at this critical moment in the evolution of galaxies, AGN and clusters. We will reveal the cluster environment of these systems in the final stages of hierarchical merging. We will probe the influence of the powerful AGN on young and evolved stellar populations. We will determine whether all radio-loud AGNs are triggered by major galaxy and black hole mergers, a fundamental piece of information for galaxy-BH co-evolution models, and strive to articulate the fundamental interrelationships that lead to the Universe of galaxies, black holes and clusters we see today.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16304 |
| Program Title: | Digging deep into massive star variability: Do massive stars vary due to internal gravity waves or stellar winds? |


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| Principal Investigator: | John | Chisholm |
| PI Institution: | University of California - Santa Cruz | |



Recent high-precision and high-cadence space-based missions have used asteroseismology to dig deep to the cores of low-mass stars and determine their internal properties. Much of the metals produced throughout the history of the Universe are forged deep in the cores of massive stars, but astonishingly little is known about the core properties of the most massive stars. Recent TESS observations found stochastic variations of blue supergiants that could be the long-sought signal of internal gravity waves near the convective cores of massive stars. These oscillations may revolutionize our understanding of the cores of the most massive stars, but winds from the same stars vary with similar periods and patterns as these stochastic oscillations. Here, we propose a 26 orbit HST/STIS E140M time-series of the stellar winds from one blue LMC supergiant, SK-67 166, which is observed to have stochastic oscillations on 0.5 day periods and has a rotation rate of 4 days. This proposed time-series will be concurrent with future TESS observations, have the same cadence as TESS, and have a total baseline of 10 days to determine whether the TESS oscillations correspond to changes in the stellar winds or result from internal gravity waves. If the stochastic oscillations are confirmed to be due to internal gravity waves, high-cadence observations and asteroseismology models can determine the interior properties of the most massive stars. If the TESS oscillations are in phase with the stellar wind variations, TESS can determine crucial properties of the elusive stellar winds. Either outcome will dramatically impact our view of the massive stars that drive galactic and chemical evolution.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16120 |
| Program Title: | Constraining the ionizing photon production efficiency for galaxies fainter than Muv = -17 |


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| Principal Investigator: | Yumi | Choi |
| PI Institution: | Space Telescope Science Institute | |



The observational consensus is that the universe was reionized by z~6, yet whether the galaxies which populated the universe at early times were capable of reionizing the Universe remains an open question. xi_ion, a conversion factor from the non-ionizing UV luminosity to the intrinsic ionizing photon production rate, is one of the key parameters to shape the history of cosmic reionization driven by galaxies, yet remains poorly constrained.

Since xi_ion solely depends on the star formation physics, such as stellar age, metallicity, initial mass function, and binarity, it can be well investigated with local analogs of high-z galaxies, particularly at the UV-faint regime (Muv > -17 ) where it is hard to access at high z. To observationally constrain xi_ion for UV-faint galaxies, we will use archival HST broad-band imaging data of resolved stellar populations in local analogs that have low metallicities, low stellar masses, and bursty star formation, expected for UV-faint, but dominant, star-forming galaxies in the early universe. We will (1) measure the intrinsic ionizing photon production rate from spectral energy distribution (SED) modeling of individual stars in a given galaxy or star-forming region; (2) measure the intrinsic non-ionizing ultra-violet luminosity density from the derived star formation history in the same region; and (3) compute xi_ion by taking the ratio of these two measurements. Our program will provide the most direct observational constraint on xi_ion along with extensive analysis of uncertainties in xi_ion measurement.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16292

Program Title: Probing the Sources of Reionization: First Measurement of the Escape Fraction of Ionizing Photons in Dwarf Galaxies Fainter than Muv = -13

Principal Investigator: Yumi Choi

PI Institution: Space Telescope Science Institute

The observed rest-frame ultraviolet luminosity function (UV LF) of star-forming galaxies at z > 6 suggests that numerous low mass galaxies were responsible for reionizing the Universe by z~6. In the current reionization models, however, the required escape fraction of ionizing photons (fesc) significantly depends on the faint-end limiting magnitude of the UV LF. Unfortunately, there are no observational constraints on fesc in this UV-faint regime; all galaxies with fesc measurements are brighter than Muv = -16. Thus, constraining fesc for galaxies around the fiducial limiting magnitude (Muv = -13) are crucial to understand the role of faint galaxies in cosmic reionization, but they are too faint to be observed at z > 7 even with JWST.

We propose to obtain multi-wavelength HST imaging of two nearby, metal-poor starburst dwarf galaxies (UGC 8091 and UGCA 292) that are fainter than Muv = -13. With these observations, we will: (1) measure the global escape fraction for galaxies below the limiting magnitude for the first time using their resolved stars; (2) map the local escape fraction in each galaxy; and (3) explore the relation between local escape fraction and physical environments. Establishing the relationships between local escape fraction and physical properties will greatly improve our understanding on the mechanisms for escape of ionizing photons. Furthermore, those relationships can be used to infer the escape fractions of high-z galaxies that can not be resolved, but with measured physical galactic properties. As a pilot program, we will pave the way to probe the contribution of extreme UV-faint dwarf galaxies to cosmic reionization.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16293 |
| Program Title: | Near Field Cosmology with Ultra-faint Dwarfs: Patchy Reionization and Sub-Solar Initial Mass Function |


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| Principal Investigator: | Yumi Choi |
| PI Institution: | Space Telescope Science Institute |



Observations of the ultra-faint dwarfs (UFDs), as relics of the epoch of reionization, allow us to probe the earliest epochs of star formation (SF). In particular, the UFDs in low density environments for most of their lifetimes provide unique tools to probe the effects of early environmental conditions on the SF histories (SFHs) of the UFDs and their sub-solar initial mass function (IMF) because they likely maintain the best `fossil' record of early local environments.

We propose to obtain deep ACS and UVIS imaging in F606W and F814W for 2 LMC satellite UFDs that are on their first approach to our Galaxy, and thus resided in the outskirts of the Local Group at high-$z$. This program is designed to identify systematic differences in the stellar populations of recently captured UFDs vs. long-term MW satellites (data available from previous programs) by using high-fidelity color-magnitude diagrams constructed from deep HST imaging as well as spectroscopically measured metallicity distribution functions. We will: (1) Establish whether SF is quenched at different times with different rate in UFDs in low density environment at early times, probing the patchiness of reionization by directly comparing with theoretical predictions; (2) Identify variations in the sub-Solar IMF across UFDs born in different environments; (3) Pave the way for a more accurate constraint on the MW halo mass.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Exoplanets and Exoplanet Formation |
| ID: | 16305 |
| Program Title: | Witnessing giant planet formation in action: a unique view of the emblematic PDS 70 system with HST |


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| Principal Investigator: | Elodie | Choquet |
| PI Institution: | Laboratoire d'Astrophysique de Marseille | |



We propose STIS coronagraphic imaging of an emblematic transition disk system, PDS 70, known to be hosting a transition disk with a large cavity, a dust ring with an asymmetric brightness distribution and two forming giant proto-planets that are still in their gas accretion phase. PDS 70 is currently the only known system where giant planet formation can be witnessed and studied directly. With this program we propose to obtained the deepest images ever obtained of this system, with the same spatial resolution as ground-based 8-m telescope in the near-infrared. With these optical images showing light scattered by submicron particles that follow gas drag in the system, we will study 1/ gas accretion by the forming protoplanets carving the cavity, and 2/ the extended structure of the disk beyond 80au that has never been resolved from the ground.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16222 |
| Program Title: | Extinction Mapping in Leo P: Resolving the Dust Properties of the Lowest-Metallicity ISM in the Local Universe |


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| Principal Investigator: | Christopher | Clark |
| PI Institution: | Space Telescope Science Institute | |



Leo P is the closest extremely metal poor galaxy that is still forming stars - only 1.62 Mpc away, with a metallicity of only 0.03 Zsol. This makes it a unique object, able to provide insights onto the ISM at these extreme metallicities, and acting as a local laboratory for understanding primitive systems at high redshift. We propose using 6 orbits of HST imaging to obtain observations of Leo P in 4 UV-NIR filters. This data will enable us to perform panchromatic extinction mapping in Leo P - fitting the multiwavelength SEDs of its stars, and modelling the dust along the line-of-sight to each. We will thereby produce a resolved map of the dust extinction in Leo P - the first ever map of the cold star-forming ISM in an extremely metal poor galaxy. This dust map will tell us the amount, location, and properties, of the dust in Leo P - providing invaluable constraints on how the ISM evolves at the lowest metallicities, and supporting the calibration of metallicity corrections for primitive systems at high redshift.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16282 |
| Program Title: | The IR CMD of the Metal-Rich Bulge Cluster NGC6553: Pushing its Age to Sub-Gyr Precision |


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| Principal Investigator: | Matteo | Correnti |
| PI Institution: | Space Telescope Science Institute | |



Globular Clusters (GCs) in the Milky Way are the primary laboratories for establishing the ages of the oldest stellar populations and for measuring the color-magnitude relation of stars. The gold standard for these studies has involved high-precision visible light investigations with the Hubble Space Telescope (HST). However, the shape of the color-magnitude relation in the visible bandpasses offers little leverage to disentangle the effects of distance, reddening, and metallicity, and these uncertainties impact our derived age measurements for GCs. Recently, a new feature has been observed in several HST WFC3-IR color-magnitude diagrams (CMDs) of nearby GCs. At low stellar masses, the stellar main sequence in an infrared (IR) CMD exhibits a sharp "kink" (due to opacity effects in M dwarfs), such that lower mass and cooler dwarfs become bluer in the F110W - F160W color baseline and not redder. As demonstrated by Correnti et al. (2016, 2018), this inversion of the color- magnitude relation offers a new opportunity to fit GC properties in the IR baseline, and to reduce their uncertainties. Here, we propose a 1-orbit HST WFC3-IR program to measure the color-magnitude relation of stars (down to 2.5 mag below the MS "kink") for the metal-rich bulge cluster NGC6553. We will establish the most accurate age for the cluster to date, with sub-Gyr precision. Combining these observations with the sample analyzed by Correnti et al. (2016, 2018), will establish an independent and sensitive test to the age-metallicity relation of clusters.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16283 |
| Program Title: | Understanding the Extreme Population in the Globular Cluster NGC 6402 (M14): Breaking the Degeneracy of Cluster Formation Scenarios |


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| Principal Investigator: | Francesca | D'Antona |
| PI Institution: | INAF-Osservatorio Astronomico di Roma | |



Multiple populations are recognized to be a common trait of nearly all ancient Globular Clusters (GCs), but no model or scenario so far proposed for their formation satisfies all the observational constraints, and observations are still necessary to discriminate among competing models.
HST observations have largely contributed to define the properties of multiple populations; in particular, HST observations have clearly revealed the photometric manifestation of the presence chemically distinct groups of stars. A recent spectroscopic investigation of NGC6402 has shown that this massive GC hosts three populations, including a primordial, a quasi-primordial and an extreme group, this latter displaying light elements abundances that in other GCs, (e.g.NGC2808), are associated with a very high helium. This peculiar distribution of abundances has stimulated innovative formation scenarios where the cluster requires two distinct sources and timescales of enrichment.
We propose to derive the `chromosome map' two-color diagram that harnesses the unique UV capabilities of the UVIS channel of WFC3 and investigate the possible abundance gap in these spectro--photometric data, by separating the different groups. We will then determine the relative helium abundances of the groups, and discern between two competing scenarios for the formation of the extreme population in this cluster: either a scenario in which these stars formed from pristine gas mixed with ejecta of a supermassive star formed and living in the first ~5-15 Myr in the cluster core; or the Asympotic Giant Branch (AGB) scenario, in which the extreme stars are formed from the pure ejecta of super-- AGB stars.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16255

Program Title: Pinpointing the Onset of Multiple Populations in Globular Clusters

Principal Investigator: Emanuele Dalessandro

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

Studies of massive stellar clusters in the Large and Small Magellanic Clouds, spanning a wide range of ages from 100 Myr to 11 Gyr, have potentially pinpointed the onset of the multiple populations (MPs) phenomenon. Focusing on clusters with similar mass (~10^5 Msun), all systems with ages above 2 Gyr were found to host MPs while clusters below this limit do not. Such a relation with age is not expected in any scenario for the origin of MPs, and constitutes one of the most important findings in the field in recent years.
One potential explanation for the observations is that MPs do exist within the young clusters, but only below a certain stellar mass limit. We propose to obtain deeper imaging of NGC 1783, a 1.7 Gyr cluster that does not show MPs on its RGB (~1.6 Msun), in order to search for splitting along main sequence stars (~1 Msun and below) caused by the chemical anomalies. Based on stellar isochrones with MPs abundance variations, we expect to observe main sequence splitting with an additional 10 orbits of exposure using our unique optical-UV filter combination. Determining if a stellar mass limit exists for MPs would consistute a major step forward in the search for the origin of the multiple populations phenomenon.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16284

Program Title: Imaging of an apparent "globular cluster galaxy"

Principal Investigator: Shany Danieli

PI Institution: Yale University

Recently a remarkable low surface brightness galaxy, NGC5846-UDG1, was discovered in archival ground-based CFHT data. The galaxy has a low stellar mass (~10^8 solar masses), a large size (r_e=1.8 kpc), and an unprecedented number of compact sources that resemble globular clusters. Keck spectroscopy confirms the association of the globular clusters and the diffuse light: they are at a common radial velocity of ~2000 km/s, close to the group velocity of ~1900 km/s. Based on the current ground-based imaging and spectroscopic data the galaxy might have up to 30% of its light in the form of globular clusters, significantly higher than any other galaxy known to date. Taking diffusion of low mass clusters into account, it is possible that the galaxy consisted solely of ~100 globular clusters when it formed. Here we request 2 WFC3/UVIS orbits to study this extreme galaxy along with its unusual globular cluster system. With WFC3/UVIS we will measure the sizes, colors, ellipticities and luminosity function of the clusters. These properties will be compared to the globular cluster systems of other galaxies (and in particular other Ultra Diffuse Galaxies), to determine whether NGC5846-UDG1's globular clusters have similarities to those in other galaxies or represent something entirely new. We will also use the data to better determine the structure and morphology of this enigmatic galaxy in order to put further constraints on its dynamical state.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | SNAP |
| Scientific Category: | Solar System Astronomy |
| ID: | 16280 |
| Program Title: | Quasi-Hildas Objects: The Missing Link Between The Hildas and Centaurs Populations |


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| Principal Investigator: | Mario | De Pra |
| PI Institution: | University of Central Florida | |



The goal of this project is to probe the nature and origin of the Hilda asteroids, a population of small bodies with orbits in stable mean-motion resonance with Jupiter. We will accomplish this objective by observing and characterizing the physical properties of quasi-Hilda objects, an unstable population hidden among the Hildas. We selected observational targets based on the dynamical study of objects close to Hilda region. Our analysis show that these quasi-Hilda objects are probable Centaur interlopers that migrated inward, temporally residing near the Hildas. We will monitor these objects for low-level activity and acquire their optical colors. Comparison between properties of these groups will provide valuable information about the surface of evolution of Centaurs when placed in a Hilda environment, which will enable us to distinguish if Hildas and Centaurs can share a similar origin, as proposed by dynamical models for the formation and evolution of the solar system.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16228

Program Title: A Multi-Cycle Monitoring Program of the Hydra's Shadow

Principal Investigator: John Debes

PI Institution: Space Telescope Science Institute

In the era of HST, JWST, and ALMA, the initial conditions of planet formation will be laid bare through the direct imaging of planet forming regions around nearby young stars. As more and more disks are observed over multiple epochs, their dynamic and variable natures are revealed, opening new avenues of study. Archival HST images of TW Hya's outer disk show that it has a shadow that orbits with a period of ~16 yr, but the full orbit of the shadow has not been observed, leaving ambiguity about its origin. We propose to observe TW Hya over the next three Cycles with HST/STIS coronagraphy to fill in badly needed orbital phase coverage of the shadow's motion and create a homogenous, high quality dataset with archival STIS observations. Our program will elucidate the physical origin of the shadow and constrain the structure of TW Hya's inner cavity independently from sub-mm imaging. Disk shadow imaging is a new tool for understanding the initial conditions of planet formation at radii inaccessible by other observations.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16285

Program Title: Linking dust extinction properties to depletion in the Milky Way

Principal Investigator: Marjorie Decleir

PI Institution: Space Telescope Science Institute

With this proposal we aim to investigate the relation between dust grain evolution, dust composition, dust extinction properties and environment in the Milky Way. To enable this, we need to expand the sample of depletion measurements, in particular to increase the number of sightlines with C and Si measurements, the two principal components of dust grains. We propose STIS spectroscopic observations towards 17 stars in a total of 31 orbits. These data (in combination with the available archival data) will allow us to study dust properties in a wide range of environments (from dense to diffuse gas clouds), and help us understand which mechanisms play a role in dust evolution in the Milky Way.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16194

Program Title: Cooking a planet: The heating and cooling of an exoplanet atmosphere

Principal Investigator: Jean-Michel Desert

PI Institution: Universiteit van Amsterdam

Exoplanets on highly eccentric orbits offer unique insights into how planetary atmospheres respond to extreme variations in stellar forcing. By tracking the reradiation of heat during the planet's closest approach to its host star (periapse passage), we can test how a planet's atmosphere responds to extreme radiative forcing, and directly measure the radiative timescales that remain ambiguous for planets on circular orbits. We propose to observe with HST/WFC3 a partial-orbit spectroscopic phase curve of the highly-eccentric transiting exoplanet, HAT-P-2b. The planet's dayside temperature changes from being a typical Hot-Jupiter (1300~K) at apoapse, with no thermal inversion expected, to that of an Ultra-Hot-Jupiter (2400~K) at periapse, at which temperature thermal inversions are expected. Therefore, this target offers an opportunity to explore the transition between Hot- and Ultra-Hot-Jupiters.

This WFC3 phase curve observation, will start before transit, continue through periapse passage, and end after secondary eclipse. The wavelength range offered by WFC3 will probe deep atmospheric pressure levels, where dynamical processes become relevant in shaping the observed spatial and temporal flux variations. The spectroscopic phase curve observation through periapse passage will be the key to constraining the timescales of atmospheric response, and to measure changes in the atmospheric vertical structure and opacities in this atmosphere. Our investigation will disentangle the contributions of radiative, dynamical, and chemical processes at work in strongly irradiated atmospheres, enabling it to become a model for the broader class of Hot and Ultra-Hot Jupiters.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16121 |
| Program Title: | Testing models of star formation in extreme environments with star clusters at the Galactic center |


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| Principal Investigator: | Tuan Do |
| PI Institution: | University of California - Los Angeles |



The Galactic center offers us an opportunity to study star formation in an extreme environment at a level of detail not accessible in any other galaxy. However, it is current unclear how the combination of high gas densities, strong cloud turbulence, radiation fields, and tidal shear in this environment affect star formation. It has been postulated that star formation can be triggered by molecular cloud collisions among the X1 and X2 galactic orbital families, or more recently, by tidal compression of clouds on a particular orbit that forms a "conveyor belt of star formation". These two theories make different predictions regarding the orbits of molecular clouds and sites of star formation at the Galactic Center. We propose to test these models by measuring the proper motions of young star clusters in the central 100 pc of the Milky Way, which due to their young age, trace the orbit of their natal clouds. We will leverage 34 orbits of archival HST WFC3-IR observations and the GAIA DR2 catalog to definitively measure the absolute proper motion of 3 young clusters: the Arches and Quintuplet cluster, and a newly discovered candidate cluster. Their motion will allow us to distinguish between these star formation scenarios, yielding insight into the physical processes and time scales involved in star formation at the Galactic Center.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Exoplanets and Exoplanet Formation |
| ID: | 16267 |
| Program Title: | Probing the Atmosphere of a Temperate Transiting Jovian Planet with an Orbital Period of 1.5 Years |


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| Principal Investigator: | Courtney | Dressing |
| PI Institution: | University of California - Berkeley | |



We request 18 orbits of HST time to observe the transit of HIP 41378 f, a Jovian planet (9.2 Earth radii) in a long-period orbit (542 days = 1.5 years) in a multi-planet system. The host star HIP 41378 is bright (Ks = 7.7, V=8.9), Sun-like (1.2 solar masses, 1.3 solar radii), and known to host at least five transiting planets. Two transits of HIP 41378 f were observed by the NASA K2 mission during non-consecutive three-month observing campaigns in 2015 and 2018, restricting the set of possible periods to a set of harmonics with a maximum period of roughly 1000 days and a minimum period near 50 days. An intensive radial velocity campaign (464 observations spanning four years) has just ruled out the remaining possibilities, revealing that the HIP 41378 f has an orbital period of 542 days and an unexpectedly low mass of 12 Earth masses. HIP 41378 f is predicted to transit on 20 May 2021 and will not transit again until November 2022. We propose to observe the 2021 transit event with WFC3/G141 to accomplish three goals: (1) probe the atmospheric composition of a cool Jovian planet; (2) investigate the possible presence of rings; (3) place constraints on the presence of exomoons. HIP 41378 f occupies a poorly-probed region of parameter space and bridges the gap between the hotter planets previously studied via transmission spectroscopy and the cooler Jovian planets in our own solar system. HST transmission spectroscopy of HIP 41378 f would provide an opportunity to investigate the influence of stellar irradiation on giant planet atmospheres and inform efforts to detect Jupiter analogs with direct imaging surveys.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16268

Program Title: Resolving Mass Benchmarks for Ultracool Atmospheres

Principal Investigator: Trent Dupuy

PI Institution: Gemini Observatory, Northern Operations

The atmospheres of low-mass stars and brown dwarfs have cool temperatures that foster abundant molecules, complex chemical and dynamical processes, and poorly understood condensate clouds. Developing accurate models of these atmospheres is critical for a wide range of problems, from interpreting the spectra of directly imaged planets to accurate modeling of the long-term evolution of the lowest-mass planetary systems. Despite increasing theoretical sophistication, evaluating the accuracy of these models has been long been limited by the lack of objects with well-determined fundamental properties.

We propose to obtain spatially-resolved optical and IR spectra for a unique sample of ultracool dwarf binaries (M7-T5 spectral types) that have high-precision dynamical masses for the individual components (30-100 Jupiter masses), derived from more than decade of orbit monitoring. Mass measurements break degeneracies between poorly known model parameters, such as those governing cloud formation and fundamental properties like surface gravity. Our HST spectra for this sample of binary systems will establish the gold standard for studies of ultracool atmospheric physics. This is the only sample of ultracool binaries that are resolvable by HST (and JWST in the future) that have precisely measured component masses.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Large Scale Structure of the Universe |
| ID: | 16122 |
| Program Title: | A Fully Self-Consistent Local Group NIR-TRGB Calibration |


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| Principal Investigator: | Meredith Durbin |
| PI Institution: | University of Washington |

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16294

Program Title: Pox 186: A Case of Complete Neutral Gas Blow-Away?

Principal Investigator: Nathan Eggen

PI Institution: University of Minnesota - Twin Cities

Energetically, it is possible for a starburst in a dwarf galaxy to blow away and completely ionize its ISM, resulting in a very high escape fraction of its ionizing radiation. Finding examples of such galaxies would ease the tension between the energy needed to reionize the universe and the ionizing energy budget available to do so. Pox 186 is an exceptional dwarf galaxy with an active starburst, yet a non-detection in deep 21cm HI observations. Its optical spectrum also shows very highly ionized gas, with an extraordinary [OIII]/[OII] ratio (> 20), and evidence of an 800 km/s outflow. Thus, Pox 186 has many physical properties consistent with those of the Green Pea galaxies - low redshift analogs of the sources responsible for the reionization of the universe. However, Green Peas are dominated by bright star clusters embedded in larger systems many times more massive than the galaxies responsible for reionization. The lower mass of Pox 186 makes it a better match to the high redshift systems. When combined with its close proximity (D~18 Mpc), Pox 186 offers a unique laboratory to study in detail the extreme properties of a galaxy like those responsible for reionization.

We will image Pox 186 with both narrow and broadband filters and obtain a UV COS spectrum with the G160M grating. The imaging will allow us to study the ionization structure to confirm the density bounded nature of the galaxy. The UV spectrum will be used to study the structure of the outflow, the stars driving the outflow, and to directly compare what one could learn from a similar unresolved, high redshift system.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Intergalactic Medium and the Circumgalactic |
| ID: | 16123 |
| Program Title: | Diffuse star formation in the proto-cluster medium: witnessing the in-situ birth of a giant galaxy |


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| Principal Investigator: | Bjorn | Emonts |
| PI Institution: | Associated Universities, Inc. | |



How did the most massive galaxies in the Universe form? Deep HST/ACS imaging has shown that a giant cluster galaxy in formation, the enigmatic Spiderweb Galaxy, is rapidly forming stars in-situ from a large reservoir of cold molecular gas across the intra-cluster medium. This proved to be the first observational support for predictions that giant cluster galaxies may condense out of accreted cold gas early in the history of the Universe. If this mode of in-situ star formation is common among massive high-z galaxies, then this may require us to revise our ideas about star formation and the early build-up of galaxies. We propose to analyze 12 orbits of WFC3 data of the one other Spiderweb-like galaxy for which deep 2-color imaging is available in the archive, namely 4C 41.17. This spectacular proto-cluster system is observed at z~4, which is the epoch where cosmic gas accretion peaks. The HST and complementary ALMA data show indications for filamentary accretion of cold gas, as well as diffuse star formation on scales of >100 kpc. Our goal is to carefully analyze the web of gas and young stars that make up the CGM/ICM, in order to gain new insights into the role that in-situ star formation plays in the early evolution of the most massive galaxies.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16208

Program Title: Improved Masses for Critical Cepheid Binaries

Principal Investigator: Nancy Evans

PI Institution: Smithsonian Institution Astrophysical Observatory

Cepheids play an important part in the Hubble Constant tension, and in evolutionary calculation benchmarks, which include comparisons with LMC Cepheids. In some cases, they lead to exotic end-stage objects. An important HST UV legacy is the measurement of the Cepheid masses, the fundamental parameter in stellar evolution. The HST high resolution E140H spectra requested in this proposal (a unique capability of HST) will measure the orbital velocity amplitude of hot companions of three Cepheids, V1334 Cyg, S Mus, and SU Cyg. This can be combined with recent infrared interferometry with the Very Large Telescope Interferometer (VLTI) and CHARA which has resolved the systems, providing visual orbits to augment the spectroscopic orbits. From this combination both masses and distances for the Cepheids have been derived, which already challenge current evolutionary tracks, even those incorporating rotation and core convective overshoot on the main sequence. The observations detailed in this proposal will improve the orbital solution through more accurate orbital velocity amplitudes of the hot companions. In addition for SU Cyg the phasing of the short period orbit of the companion will be more precise. The requested observations are predicted to yield mass solutions accurate to a few percent. These will be the most accurate Cepheid mass determinations available to quantitatively test the underlying physics at this stage.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Galaxies

ID: 16124

Program Title: Testing a new physical model for the formation of galactic disks and its implications for star formation variability, ISM kinematics and galactic winds

Principal Investigator: Claude-Andre Faucher-Giguere

PI Institution: Northwestern University

The origin of disk galaxies is a central problem in galaxy formation. In the prevailing paradigm, disks inherit angular momentum (AM) from their host halos and AM conservation sets disk sizes. However, deep HST surveys have revealed that disk galaxies are a recent phenomenon: disks start to appear in massive galaxies only around z~2 and disk settling in lower-mass galaxies is delayed until even later. Since halo spins do not depend on mass or redshift, these observations directly contradict the standard model. In the past few years, high-resolution cosmological simulations have produced predictions qualitatively consistent with observations, with simulated galaxies experiencing a switch to well-ordered disks only as they approach L^*. Intriguingly, the simulations predict that disk formation is accompanied by important changes in star formation and galactic wind properties: SFRs switch from highly bursty to time steady, and galactic winds (which are ubiquitous at high z) are strongly suppressed. This project will use a large suite of simulations from the FIRE project to systematically test different models for disk formation. These models include recently proposed ideas on the failure of stellar feedback in early galaxies, as well as connections between halo gas and disk physics (including AM exchanges). We will in particular test in detail a new model for disk formation based on the development of hot atmospheres around massive galaxies, which can simultaneously explain the different observed transitions. We will produce directly testable predictions, including mock HST and JWST images/IFU data, indicators of SFR variability, and diagnostics of ISM kinematics and winds.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Solar System Astronomy

ID: 16306

Program Title: Towards a more complete understanding of Haumea's family tree

Principal Investigator: Estela Fernandez-

PI Institution: University of Central Florida

The dwarf planet Haumea is the only object in the trans-Neptunian population known to be the parent body of a collisional family. The accepted family of objects share extremely low delta-V values relative to Haumea, and very strong water ice absorption bands (like Haumea itself). Several collisional-formation mechanisms for the family have been proposed, but none of these models seem to satisfy all of the physical and dynamical properties of Haumea and its family. This could reflect problems with the models, but could also be a result of an incomplete census of the family resulting in biases such as the very low delta-V, incorrect inferred size distribution, a paucity of fainter (low albedo and/or smaller) objects, or combinations of those biases. In recent years, deep surveys in the trans-Neptunian region have detected new objects that could be part of the family. A recent dynamical study by Proudfoot and Ragozzine (2019) has identified new objects with comparably low delta-V values to the accepted family members, many of which are too faint to be effectively characterized from the ground. Here we propose SNAP observations of 20 of these fainter targets using HST/WFC3 in the F139M and F153M filters in order to cahracterize the strength of their 1.5 micron water-ice absorption, and test whether any of them possess stronger absorptions than were found in previous large WFC3 studies of TNOs.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16178

Program Title: Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window

Principal Investigator: Alex Filippenko

PI Institution: University of California - Berkeley

We propose to obtain a series of three early-time UV spectra of one stripped-envelope core-collapse supernova (either a normal SN Ib or a normal SN Ic), starting well before maximum brightness. The underlying nature of these objects, from the mass-loss process stripping the envelope to the details of the explosion mechanism, remain mysterious. Connections to gamma-ray bursts and X-ray flashes further motivate this study. Many high-redshift SNe are being found in deep transient surveys, but the ability to distinguish between thermonuclear Type Ia SNe and stripped-envelope core-collapse SNe requires thorough knowledge of the latter at UV wavelengths with a low-z object. By comparing the evolution of the spectra as the photosphere recedes to deeper layers of the ejecta with our time series of spectral models, we will gain a better understanding of the explosion mechanism and the degree of mixing during the explosion. Moreover, we should be able to determine the metal content of the progenitor's outer layers with our spectral models and compare with the measured metallicity of the environment. The heterogeneity seen in stripped-envelope SNe compels us to choose a normal SN Ib or SN Ic, objects with DIFFERENT characteristics than the ones that HST has observed in previous Cycles (SNe Ic-pec, IIb, Ibn), thereby gaining further insights into this unique class of cosmic explosion. We need to seize this opportunity now, while we have access to the space UV, and indeed the UV is an HST Cycle 28 priority.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Stellar Physics and Stellar Types

ID: 16179

Program Title: A Snapshot Survey of the Sites of Recent, Nearby Supernovae

Principal Investigator: Alex Filippenko

PI Institution: University of California - Berkeley

During the past two decades, robotic (or highly automated) searches for supernovae (SNe) have found several thousand SNe, many of them in quite nearby galaxies (d < 30 Mpc). 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 obtain HST snapshot images of the sites of some of these nearby objects, to obtain late-time photometry (through two filters) 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 at these SN sites (those of core-collapse SNe often being especially rich in massive, luminous stars), to constrain the reddening and SN progenitor masses. We will search for light echoes around SNe, an important clue to their progenitor systems. When the SN is detected at late times (thereby providing a precise position) and deep HST archival pre-explosion images of the SN site are available, we will search for and characterize the nature of the progenitor. We will also image some "SN impostors" to verify whether they are indeed superoutbursts of luminous blue variable stars and survived the explosions, or a new/weak class of massive-star explosions. Our proposed snapshots in Cycle 28 will complement and extend the set of existing SN sites imaged with HST by various investigators in previous cycles.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Intergalactic Medium and the Circumgalactic

ID: 16125

Program Title: Probing Reionization With the Circumgalactic Medium

Principal Investigator: Kristian Finlator

PI Institution: New Mexico State University

I will study how observations of the physical impact that young galaxies had on their local environments test the hypothesis that galaxies dominated cosmological hydrogen reionization. A generation of deep HST-based surveys has now detected the first galaxies that emerged from the cosmic dark ages. Although these efforts offer a treasure-trove of insight into the early stages of galaxy formation, the extent to which the young galaxies actually ionized and heated their surroundings remains essentially unconstrained. Fortunately, the close spatial association between galaxies and their circumgalactic media suggests a simple test: if galaxies were bright ionizing sources, then fewer are expected around strong high-ionization metal absorbers such as triply-ionized carbon and silicon (CIV and SiIV). Conversely, if galaxies did not dominate reionization, then more are required to generate such an absorber. This new approach requires theoretical input: how many bright galaxies are expected near a strong absorber? How does this expectation depend on the absorber's properties and on assumptions regarding the galaxies' ionizing efficiency? In order to open up this field, I address these questions through the use of cosmological radiation-hydrodynamic simulations that self-consistently model both galaxy growth and reionization. In the process, I will reveal how existing and upcoming observations of the galaxy-absorber connection directly constrain the contribution that galaxies made to reionization.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Large Scale Structure of the Universe

ID: 16238

Program Title: Measuring the Effect of Progenitor Metallicity on Type Ia Supernova Distance Estimates

Principal Investigator: Ryan Foley

PI Institution: University of California - Santa Cruz

Despite using Type Ia supernovae (SN Ia) to precisely measure cosmological parameters, we still do not know basic facts about the progenitor systems and explosions. Theory suggests that SN Ia progenitor metallicity is correlated with its peak luminosity, but not how quickly it fades, which we use to calibrate the luminosity and measure distances. This effect should lead to an increased Hubble scatter, reducing the precision with which we measure distances. If the mean progenitor metallicity changes with redshift or population, cosmological measurements such as the dark energy equation-of-state parameter and the Hubble constant could be biased. Models also indicate that changing progenitor metallicity will have little effect on the appearance of optical/NIR SN data, but significantly alter UV spectra. These data can only be obtained with HST.

Previous HST observations of 2 "twin" SN (having nearly identical optical spectra and light-curve shapes) with different UV spectra and peak optical luminosities indicate progenitor metallicity differences consistent with models. To determine the overall impact of progenitor metallicity on cosmological measurements, we must increase the sample.

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

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Stellar Physics and Stellar Types

ID: 16239

Program Title: Snapshot Observations of Nearby, Recent Supernovae and Their Environments

Principal Investigator: Ryan Foley

PI Institution: University of California - Santa Cruz

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

Late-time (>200 days after explosion) HST observations of SNe measure the amount of radioactive material generated in the explosion and probe the circumstellar environments of the progenitor systems at radii inaccesible through other means. These same images can be used to examine the SN environment, and from nearby stars, we can constrain the progenitor star's age. For SNe Ia, we can determine if the progenitor system originated in a globular cluster, which through dynamical processes should overproduce SNe Ia relative to the field. These observations will also precisely determine the SN position, allowing future observations to search for companion stars. Finally, for SNe Iax, which are thought to not disrupt their white dwarf progenitor stars, we can detect the surviving star when leftover radioactive material forces it to the Eddington limit.

We have assembled a sample of ~100 recent, well-observed SNe, that are sufficiently close that this science can be done with short HST exposures. Combined with the statistical nature of these studies, this program is perfectly matched to snapshot observations.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16229 |
| Program Title: | Precise distances and photometry for the Y dwarf population: unlocking the secrets of our coolest neighbours |


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| Principal Investigator: | Clemence | Fontanive |
| PI Institution: | University of Bern | |



We propose for WFC3/IR imaging of 19 Y brown dwarfs to measure the most precise parallaxes and proper motions to date, and define a uniform catalogue of near-infrared F105W/F125W/F160W photometry for the vast majority of ultracool Y dwarfs. Accurate distances are vital for confident interpretations of measured quantities and assessments of inherent properties, which are indispensable to characterise the atmospheres of these giant planet analogues. The challenges associated with astrometric and spectrophotometric observations for such intrinsically faint objects result in highly incomplete and heterogeneous datasets, that severely lack reliable absolute calibrations.

HST provides a unique platform to obtain both precise astrometric parameters and photometry for Y dwarfs, with an exquisite astrometric precision and unmatched capabilities at these wavelengths for observations of such cold objects. Robust and uniform parallax measurements for the major part of the Y population will be essential to enhance our heavily scattered understanding of their characteristics, and improve theoretical models that lack empirical validation at the coldest temperatures.

Homogeneous sets of reliable distances and multiband photometry will allow for unprecedented analyses of colour-magnitude diagrams for the Y spectral sequence, enabling key tests of secondary effects like gravity or metallicity on the complex appearances of Y dwarfs. Constraining the kinematics and fundamental properties of these objects will be crucial in preparation of upcoming missions like JWST, which, combined with robust calibrations, will offer invaluable new glimpses into these puzzling planetary atmospheres.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16165

Program Title: Towards a Comprehensive Search for Surviving Companions to Stripped-Envelope Supernovae

Principal Investigator: Ori Fox

PI Institution: Space Telescope Science Institute

We propose optical+UV observations at the sites of nearby stripped-envelope supernovae (SNe) to search for expected surviving binary companions from the progenitor systems. Directly measuring the photometry (or deep upper limits) of SN companions provides a critical constraint on the underlying physics in binary evolution models, which in turn has far-reaching implications in all of astrophysics. While a number of binary star models exist, the detailed physics remain unconstrained (e.g., winds, rotation, metallicity, nuclear burning instabilities). Current models predict that the majority of stripped-envelope SNe (i.e., IIb, Ib, and Ic) have a close binary companion, but the expected endpoints for these companions vary based on the physics of the binary interaction and evolution. An unbiased, comprehensive, statistically complete sample of direct companion observations is necessary to measure the actual binary fraction and stellar type. To date, however, only several candidate detections exist. Our program will build a meaningful sample by providing robust detections (or deep upper limits) of the most viable candidates out to a reasonable detection limit (~20 Mpc). NUV (F275W/F336W) imaging offers an optimum detection strategy for the expected hot, blue stellar companions, while optical imaging can rule out shock interaction contributions and probe less likely, but possible, cooler star companions. Given HST's time horizon, the degrading UV response on WFC3, and the requisite waiting period to allow the SN to fade before conducting a companion search, now is the time to take full advantage of HST's unique UV capabilities.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16189

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 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 28's UV Initiative, this program offers new insights regarding both the progenitor and explosion characteristics of the SN Ia-CSM subclass.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16166

Program Title: Essential Ultraviolet Stellar Characterization for Guaranteed JWST Transiting Planet Targets

Principal Investigator: Kevin France

PI Institution: University of Colorado at Boulder

JWST will launch during HST cycle 28 and begin an unprecedented era in atmospheric characterization for all types of exoplanets. Atmospheric spectroscopy of warm rocky planets, sub-Neptune, and Jupiter-mass planets will be obtained through a robust set of guaranteed transiting planet observations (the JWST ERS and GTO programs). To accurately model and interpret observations of these planets' atmospheres, we must understand the high-energy SED of their host stars: FUV and NUV-driven photochemistry shapes an atmosphere's molecular abundances and the formation of hazes, EUV irradiation can erode a planet's gaseous envelope, and flares can affect long term stability.

A number of recent surveys have used HST's UV capabilities to characterize the energetic irradiance spectra across a range of stellar masses, ages, and activity levels. While these surveys have proven invaluable for predicting photochemical tracers and evolution of an exoplanet's atmosphere, they have also shown scatter in behavior and irradiance properties for stars of similar type. As a result, direct UV observations remain the gold standard for understanding the effects of the stellar irradiance on a specific exoplanet. We propose to obtain temporally-resolved UV (1150-3200 Ang) stellar spectroscopy of the 13 JWST guaranteed time targets with no UV characterization data in the HST archive. Our proposed observations will provide the UV context necessary to determine the likelihood of atmospheric formation and retention, the identification and interpretation of atmospheric chemistry, and the impacts of stellar activity on the exoplanet atmospheric stability.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Solar System Astronomy

ID: 16167

Program Title: Confirming the binarity of Kuiper Belt Object 2015 RR245: a test of the streaming instability

Principal Investigator: Wesley Fraser

PI Institution: Dominion Astrophysical Observatory

Binary systems are prevalent throughout the Kuiper Belt, with roughly 110 systems known to date. The question of how these binary systems formed is of great interest, as each proposed mechanism has its own implications for the conditions in the early Solar System during planetesimal growth. The favoured mechanism - streaming instability in a gaseous dusty disc followed by gravitational collapse of a pebble cloud (SI-GC) - naturally produces many of the observed features of Kuiper Belt binaries. This mechanism also predicts the presence of a class of relatively massive systems with nearly equal sized primary and secondary components. Such systems are virtually absent from the observed sample, with the exception of the Varda-Ilume system. Here we propose observations of the KBO 2015 RR245, the ground-based observations of which hint at a barely resolved binary. The inferred brightnesses and locations of the primary and secondary are consistent from image to image, and imply a system with mass and mass ratio very similar to the Varda system. If binarity is confirmed, RR245 and Varda together would reveal the presence of a class of binary that has simply gone unnoticed, and would solve one of the current tensions between observations and formation simulation of SI-GC. We propose a simple two orbit WFC3 program, with an aim to confirm the binarity of RR245. Observations will be tuned to avoid non-detection in the case of overlapping binary components, and will enable measure of both component's colors and relative sizes, properties that are necessary to confirm consistency with formation via SI-GC.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Large Scale Structure of the Universe

ID: 16126

Program Title: An Independent Appraisal of the Cepheid Distance Scale

Principal Investigator: Wendy Freedman

PI Institution: University of Chicago

Cepheids are at the nexus of a debate about the possibility that the concordance LCDM model of the Universe is deficient and that new physics is needed to resolve an apparent discrepancy between the local value of H_o and the cosmologically-modeled one.

We are proposing to undertake a new and independent determination of H_o using archival imaging of 36 galaxies that contain Cepheids and are hosts to Type Ia supernovae. The Cepheid distance scale is just too imprtant for it not be re-reducded, re-analysed and independently assessed.

We have already developed a pipeline that undertakes crowded-field photometry using (DAOPHOT), fine-tuned to the ACS using spatially-variable Tiny Tim PSFs; this will be extended to WFC3 data. Extensive artificial star experiments will be run; and half of our team will undertake the analysis completely blinded, while the other half (without any cross-talk) will run open loop. Both results will be published unchanged.

We will make all of the data-reduction and analysis sofware publically available on Github. Intermediate data products will be archived at MAST so that users can re-analyze the data from those intermediate points onwards.

Enroute to a new and self-consistent value of the Hubble constant, the other Science Products will be
Crowded-field VI photometry, cross-matched for all detected point sources in 36 galaxies.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Large Scale Structure of the Universe

ID: 16127

Program Title: Absolute Magnitude Calibration of Type Ia SNe at 1%: Doubling the Sample of TRGB Host-Galaxy Supernova Calibrators

Principal Investigator: Wendy Freedman

PI Institution: University of Chicago

The tip of the red giant branch (TRGB) method is a powerful and precise extragalactic stellar distance indicator. Indeed, the TRGB Method has recently been used to measure a value of the Hubble constant of 69.8 km/s/Mpc, which falls squarely between the far-field value (67.4 km/s/Mpc), as inferred from the (cosmological) Planck mission observations of the CMB, and that of the other local (stellar) value measured by Cepheids (73.5 km/s/Mpc). Before suggestions of the possibility of new physics are accepted as necessary to reconcile the near and far values of the Hubble constant, understanding the differences in the local distance scale, and the level of systematic errors is crucial.

There are now over 30 galaxies in the HST Archive that are known to be hosts to well-observed Type Ia SNe. These all have VI imaging of sufficient depth that the TRGB can be measured for those stars clearly detected and uncrowded in their dust-free halos. SNe Ia are known to have an intrinsic dispersion of 0.10 mag, derived from samples of over 100 SNe in the far field flow. SNIa in nearby galaxies, having TRGB distances, give a consistent and totally independently-determined scatter of 0.11 mag. With this proposal we will double the number of distances to TRGB-calibrated supernova host galaxies, and in doing so, bring the systematic error on the Hubble constant, attributable to the supernova calibration, down to 1.0%. This will be below the systematic floor currently set by the geometric distance to the LMC at 1.2%. This program will provide the most precise value of the near-field value of Hubble constant measured to date.

All data will be made public upon publication.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Exoplanets and Exoplanet Formation |
| ID: | 16307 |
| Program Title: | 'A' Gap: Exploring the new parameter space of ultra hot Jupiters around A-type host stars |


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| Principal Investigator: | Guangwei Fu |
| PI Institution: | University of Maryland |



Ultra hot Jupiters are unique planetary objects that have a dayside temperature exceeding 2200K due to intense irradiation from the host star. An important aspect hereby is the spectral type of the host star, which determines the wavelength range at which most of the stellar radiation is emitted. This in turn impacts the efficiency of the planetary atmosphere to absorb the incoming stellar flux. As most of the observed ultra hot Jupiters orbit F/G stars, the parameter space of planets around A-type stars has not been explored sufficiently to be able to empirically verify this theoretical prediction. We propose to observe two recently discovered ultra hot Jupiters that orbit A-type stars to study how hot stars can affect the thermal structure and atmospheric composition of the planet.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16226

Program Title: Metallicity Distribution Functions of Quenched Field Dwarf Galaxies

Principal Investigator: Sal Fu

PI Institution: University of California - Berkeley

Environment is thought to play a central role in quenching low-mass dwarf galaxies. However, an increasing number of dwarf galaxies discovered in isolation suggest that mechanisms other than environment can quench dwarf galaxies. Here, we propose deep WFC3/F395N (Ca H & K) imaging to measure metallicites (~0.1-0.2 dex) for hundreds of individual stars in Cetus and Tucana, the two nearest examples of isolated quenched dwarf galaxies. Our Ca H & K photometry will provide an order-of-magnitude increase in the number of stars in each systems with reliable metallicities (from ~40 to 400), enabling the first detailed study of the metallicity distribution functions (MDFs), and the physics they encode, in isolated quenched dwarf galaxies. Specifically, we will (1) construct and characterize detailed MDFs for Cetus and Tucana from a number of stars comparable to MW satellites; (2) use our MDFs to differentiate between signatures of external vs internal quenching in low-mass galaxies; and (3) combine our MDFs, HST-based SFHs, and HST-based proper motions (and orbital histories) to complete our knowledge of these enigmatic galaxies' formation histories.

This program will provide qualitatively new insight into how and why isolated low-mass galaxies stop forming stars. The construction of MDFs in such distant systems is only possible due to the excellent blue-sensitivity and angular resolution of HST -- no other ground- or space-based facility can acquire this data. This novel use of HST will establish it as a leader for measuring stellar metallicities in galaxies located at large distances from the Milky Way.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16223

Program Title: Star-forming clumps in jellyfish galaxy tails

Principal Investigator: Marco Gullieuszik

PI Institution: Osservatorio Astronomico di Padova

Star-forming, Halpha-emitting clumps are found in the tails of galaxies undergoing intense ram-pressure stripping in galaxy clusters (so-called jellyfish galaxies). These clumps offer a unique opportunity to study the star formation process under extreme conditions, in the absence of an underlying disk and embedded within the hot intracluster medium. Yet, a comprehensive, high spatial resolution study of these systems is missing.
We propose to observe the first statistical sample of clumps in the tails (250) and disks (500) of six jellyfish galaxies, using a combination of broad-band filters (UV- to I) and a narrow-band Halpha filter. HST observations are needed to study the sizes, stellar masses and ages of the clumps and their clustering hierarchy, investigating whether the hierarchical structure in the tails follows the one in disks. We will study the clump scaling relations, explore the universality of the star formation process and verify whether a disk is irrelevant for star formation, as hinted by jellyfish galaxy results so far. We will investigate the nature and fate of these clumps, as well as the nature of the diffuse emission in the tails where smaller, so far undetected clumps might exist. The unmatched spatial resolution of HST (70pc in our case) will create a powerful synergy with available multi-wavelength data at lower (1kpc) resolution (MUSE, ALMA, JVLA).
This program is the first HST systematic study of jellyfish galaxies at low-z. A relatively modest investment of HST will lead to a breakthrough in understanding the connection between ram pressure stripping and star formation, as well as the mechanisms regulating the star formation process in general.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16295

Program Title: A Spectroscopic Redshift for the Most Luminous Galaxy Candidate at z~11

Principal Investigator: Yuichi Harikane

PI Institution: University College London

Detailed studies of the ages and star formation histories of the most distant known galaxies promise to provide new insight into the epoch when the first sources emerged from the cosmic dark ages as well as the practicality of using JWST to search for their progenitors. Recent progress analysing the spectral energy distributions of two spectroscopically-confirmed z>9 galaxies, MACS1149_JD1and GNz-11, has been particularly informative. One surprise is the remarkable brightness of GNz-11 at z=11 which suggests that luminous sources may somehow emerge very promptly. Until now, GNz-11 has been regarded as an anomaly. Here we propose to obtain WFC3/G141 grism spectroscopy for a second luminous candidate thought to be at z~10.9, XMM3-3085 with MUV=-23.7 mag. Both sources are consistent with being drawn from the bright end of UV luminosity function at z=5-10. However, as was the case for GNz-11, without a spectroscopic redshift a low redshift interloper or a faint dwarf star cannot be excluded. A suitable spectrum for XMM3-3085 cannot be secured with ground-based instruments because of the low atmospheric transparency at the expected wavelength of its Lyman break. Confirmation of the redshift of XMM3-3085 can be economically secured with HST and would strengthen the evidence supporting the emergence of luminous galaxies at z=11, only 400 Myrs after the Big Bang. This would provide a major impetus for surveys for earlier galaxies with JWST.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16256 |
| Program Title: | A Sensitive Test for Far Ultraviolet CO absorption in the Outflow of our Nearest Supernova Progenitor - Antares |


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| Principal Investigator: | Graham | Harper |
| PI Institution: | University of Colorado at Boulder | |



The massive red supergiant Antares (alpha Sco A: M1 Iab) is an excellent star to test theoretical models of mass loss because its distance, age, stellar parameters, mass-loss rate, and interstellar reddening are well established. The early-M supergiants pose a particular challenge for models of mass loss driven by radiation pressure on molecules and/or dust: The circumstellar molecular abundances and dust-to-gas mass ratios are lower than for later-M spectral-types, but they still manage to drive massive winds.

We request deep FUV and NUV observations to perform an extremely sensitive test for the most robust circumstellar molecule, CO, by observing its Fourth-Positive electronic bands against the FUV continuum of the M supergiant Antares. These observations will enable us measure any CO present in the outflow, and to place upper-limits on the effective radiation acceleration it can provide. The proposed observations will also provide an invaluable dataset for Antares, the oft neglected southern twin of Betelgeuse, and our nearest Type II supernova progenitor.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16209

Program Title: Highly ionized gas in extreme starburst galaxies: high resolution He II and (the first) C IV emission imaging

Principal Investigator: Matthew Hayes

PI Institution: Stockholm University

Nebular emission lines in the far ultraviolet are rapidly drawing attention as quantitative diagnostics of nebular gas. In the coming decades, they will be among the few information-carriers regarding the ionized ISM of faint galaxies at the highest redshifts. In particular, the C IV 1550 AA and He II 1640 AA lines are very prevalent in low-metallicity dwarf starbursts. However when using them to estimate the conditions in the ISM, C IV and He II diagnostics provide degenerate solutions between photo- and shock-ionization scenarios.

Here we propose to obtain emission line images of two nearby starburst galaxies with the strongest emission in He II recombination line and C IV 1550 AA doublet. This will be the first C IV emission imaging ever performed. The targets are well-known low-metallicity starbursts, and analogs of galaxy building blocks at the highest redshifts. We will measure the C IV and He II light profile, and compute the total C IV (large-aperture) luminosity for the first time. Most importantly we will map line ratios involving C IV, He II, and H-alpha at ~20 pc resolution, while state-of-the-art modeling will derive the ionizing output of the star clusters. Hence we will directly couple stellar parameters to nebular diagnostics on the requisite spatial scales. Our results will determine the impact of photoionization and shocks to UV line diagnostics, which will be pivotal for understanding the ISM conditions of the earliest galaxies.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Intergalactic Medium and the Circumgalactic |
| ID: | 16128 |
| Program Title: | Triggering Precipitation at the Edge of the Galaxy: A New Theoretical Approach |
| Principal Investigator: | Fabian Heitsch |
| PI Institution: | University of North Carolina at Chapel Hill |

The circumgalactic medium (CGM) and intergalactic medium (IGM) are key ingredients for the evolution of our Galaxy, providing mass reservoirs of generally metal-poor gas for continued star formation in the disk. Recent progress in understanding these processes has been stimulated by UV absorption-line studies, mostly with HST/COS, that identified chemical signatures of extended galactic halo gas. Observations and simulations suggest that density perturbations from passing satellite galaxies or Galactic outflows can trigger condensations, which cool, condense, and eventually accrete onto the Galactic plane as material for star formation. These processes are not unique to the Milky Way; they are observed in other galaxies as well. We will pursue two related theoretical objectives both analytically and numerically: (1) Explore the structure of a potential "galactopause" at which gas outflows driven by galactic star formation stall against the pressure of the CGM and IGM. Accumulation of gas at these interfaces would naturally define a sphere of influence through chemical enrichment of the IGM; (2) Explore numerically the different formation scenarios of precipitation (wakes of satellites, turbulent compressions, stagnating outflows) and estimate the rate of precipitation, including observational diagnostics. Although the evolution of gas clouds falling onto the Galactic disk has been studied before, our program differs by emphasizing initial conditions of and triggers to the formation of precipitation, key processes for cloud survival. Our studies should therefore close a gap in understanding galactic matter cycles.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16129 |
| Program Title: | Outflows and Disks around Young Stars: Synergies for the Exploration of Ullyses Spectra (ODYSSEUS) |
| Principal Investigator: | Gregory Herczeg |
| PI Institution: | Peking University |

The ULLYSES DDT Survey of low-mass pre-main sequence stars, coupled with forthcoming data from ALMA and JWST, will provide the foundation to revolutionize our understanding of the relationship between young stars and their protoplanetary disks. A comprehensive evaluation of the physics of disk evolution and planet formation requires understanding the intricate relationships between the mass accretion, mass outflow, and disk structure. Our team of 55 young star experts from around the world will bring their combined knowledge to bear on the ULLYSES FUV spectral database, ensuring a uniform and systematic approach in order to (1) measure how the accretion flow depends on the accretion rate and magnetic structures, (2) determine where winds and jets are launched and how mass loss rates compare to accretion, and (3) establish the influence of FUV radiation on the chemistry of the warm inner regions of planet-forming disks. We will also work together to acquire and provide contemporaneous observations at X-ray, optical, near-IR, and mm wavelengths to enhance the impact of the ULLYSES data. By the end of our comprehensive 3-year program, we will provide the best measurements of the levels and evolution of mass accretion of protoplanetary disks, the properties and magnitudes of (inner) disk mass loss, and the UV radiation fields that determine ionization levels and drive disk chemistry. This team addresses the need for labor essential to maximize the scientific return on the ULYSSES DDT young star program, in line with funding requests allocated to Legacy GO programs or Treasury programs.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16130 |
| Program Title: | Adding the Final Piece to the Metallicity Puzzle of Star- Forming Galaxies: Stellar Abundances from Integrated Light |


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| Principal Investigator: | Svea | Hernandez |
| PI Institution: | Space Telescope Science Institute | |



Extragalactic metallicities are primarily inferred through studies of the neutral and ionized gas (H I and H II). We propose to obtain accurate metallicities and ages from the integrated light of young star clusters for an archival sample of 12 nearby star-forming galaxies. The neutral and ionized gas contained in our galaxy sample has been amply studied in the UV and optical range. We will be able to directly compare H I and H II metallicity diagnostics with those determined from the stellar component in the UV with the ultimate goal to provide the first quantitative conversion between stellar, neutral- and ionized-gas diagnostics. We will investigate the chemical composition of the different components (stars and multi-phase gas) as a function of galactic properties. Now more than ever it is critical to acquire a better understanding of UV spectra as this will be the only wavelength regime accessible for high-z studies (z~3-8) with the upcoming space- and ground-based facilities (JWST, TMT, ELT). The UV analysis here proposed will create a metallicity benchmark against which future high-z stellar population observations can be compared, allowing us not only to probe the earliest galactic environments (stars+gas), but also galactic chemical evolution through cosmic time.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Physics and Stellar Types

ID: 16131

Program Title: CMFGEN: A Key Spectroscopic Tool for Astrophysicists

Principal Investigator: D. Hillier

PI Institution: University of Pittsburgh

Spectroscopic analyses are a crucial tool for investigating properties of stars and supernovae (SNe) which in turn provide constraints on stellar and galactic evolution. CMFGEN is a time-dependent non-LTE radiative transfer code designed to model the spectra of stars and SNe. It is available online and is used at many research universities and institutions around the world. We plan to extend and enhance the capabilities of CMFGEN. These improvements will be particularly useful for analyzing existing spectra of massive stars in the HST archive, and for analyzing spectra of OB and Wolf-Rayet (WR) stars and Luminous Blue Variables (LBVs) that will be obtained as part of the Director's Discretionary Legacy program, ULLYSES.

Despite extensive developments over the last few years there are still many unanswered questions related to stellar evolution, and in particular to massive star evolution. While we understand the basic principles behind radiation-driven winds, there are issues regarding the accuracy of derived mass-loss rates. Mass-loss rates are a key ingredient in stellar evolution calculations. Despite the ubiquity of binaries among massive stars, the role of binarity in producing WR stars is still debated. Mixing, which brings CNO-processed material to the stellar surface, is not fully understood. More recently it has been realized that the iron convection zone can inflate the radius of the star. Does this inflation explain the discrepancy between derived and evolutionary radii of WN and WC stars, and what role does it play in other stars? Spectroscopic analyses provide a crucial means of addressing these and other important topics.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Large Scale Structure of the Universe

ID: 16132

Program Title: A Mira Distance to M101: Towards a Sub-3% Measurement of the Hubble Constant with Miras

Principal Investigator: Caroline Huang

PI Institution: The Johns Hopkins University

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

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16240

Program Title: Pinning down multi-phase mixing of metals within star-forming galaxies

Principal Investigator: Bethan James

PI Institution: Space Telescope Science Institute - ESA

Treating metals as homogeneous distributions throughout star-forming galaxies (SFGs) is no longer acceptable. Chemical inhomogeneities have been detected in the ionized gas of numerous SFGs via spatially resolved studies, with large implications for the flow of metals within and around galaxies. However, metals exist in multiple phases and, at present, the spatial distribution of metals throughout the neutral gas in SFGs remains unknown. Recent high-resolution galaxy-scale hydrodynamical simulations have made significant advancements, opening up crucial questions concerning mixing timescales and the presence of localized enrichment between the two gas phases. Answers can only be found by measuring both the neutral and ionized gas abundances along multiple identical sightlines throughout a nearby SFG. Here we propose COS G130M spectroscopy of 6 sightlines in NGC5253 (4 new, 2 archival), to measure the neutral gas abundances towards clusters ranging between 1-15Myr. When combined with ionized gas abundances of spatially matched spectra from VLT/MUSE, this unique dataset will provide the first spatially resolved study of metals both within and between two phases within a galaxy. Determining whether metal abundance offsets exist between the two phases, both globally and locally across a range of HII region properties, enables an exceptionally detailed sampling of chemical mixing scenarios and enrichment mechanisms experienced in SFGs. NGC5253's low-metallicity and high SFR make our findings applicable to both nearby and high-z SFGs. This remarkable study will provide the first observational test of multi-phase abundance patterns in cosmological simulations of dwarf galaxies.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Large Scale Structure of the Universe

ID: 16252

Program Title: TREASUREHUNT: Hubble's UV-Visible treasury imaging of the JWST NEP Time-Domain Field

Principal Investigator: Rolf Jansen

PI Institution: Arizona State University

We propose to complete the near-contiguous UV-Visible imaging of the JWST NEP Time-Domain Field, the best field within the JWST Continuous Viewing Zones to conduct deep and wide extragalactic JWST surveys at arbitrary cadence or orientation. This recently developed, ~14' diameter time-domain field near the North Ecliptic Pole (1) is devoid of sources brighter than m_AB ~ 16 mag at 2-4 micron that would deeply saturate JWST/NIRCam, (2) has the lowest possible zodiacal foreground, (3) has low Galactic foreground extinction, and (4) has a wealth of deep ground- and space-based ancillary data from X-ray through radio. Deep UV-Visible HST imaging to m_AB ~ 28 mag exists for the inner ~9' diameter portion of this field. Completing the coverage of the NEP Time-Domain Field to the same depth, in combination with extant data, allows the community to:

(1) Establish a baseline UV-Visible detection image at ~0.07" FWHM at wavelengths inaccessible to JWST, and map transients and moving objects in areas of 2- and 3-epoch overlap;
(2) Identify rest-frame UV-bright objects at z < 6 that would contaminate JWST ultra-high-z galaxy samples;
(3) Identify galaxies with steep intrinsic UV-Visible SEDs indicative of (weak)AGN, assess the escape of LyC photons at 2 < z < 3, and place limits on that escape and IGM porosity at z < ~3.5; and
(4) Study mass assembly and evolution of all significantly resolved UV-bright galaxies at z < 6 on a 'pixel-by-pixel' basis.

In order to maximize the scientific return of early-release JWST science, it is critical to image this field in the

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16133 |
| Program Title: | A Comprehensive Investigation of Gas-Phase Element Abundances and Extinction by Dust in the Large and Small Magellanic Clouds |


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| Principal Investigator: | Edward | Jenkins |
| PI Institution: | Princeton University | |



A major part of the HST ULLYSES observing program consists of an ambitious initiative to record medium-resolution UV spectra of a large number of hot stars in the Large and Small Magellanic Clouds. The data that will emerge from this comprehensive survey will enable us to measure gas-phase abundances for a broad range of different elements for these two nearby galactic systems with low metallicities and, at the same time, define the character of extinction as a function of wavelength arising from dust in both the Milky Way and Magellanic Cloud systems. Our objective is to determine the composition of this dust after we understand how rapidly the elements are depleted from the gas phase as they condense into solid form. While useful on its own, this information will also be of value to investigations of abundances in distant Damped Lyman Alpha systems, where observed atomic column densities must have upward corrections to compensate for the depletions in order to arrive at true total abundances.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Solar System Astronomy

ID: 16308

Program Title: Active Asteroids Rapid Response

Principal Investigator: David Jewitt

PI Institution: University of California - Los Angeles

Active asteroids are a recently discovered solar system population in which diverse mechanisms generate unexpected asteroid mass loss. They are interesting scientifically because the mechanisms (rotational disruption, impact, volatile sublimation and others not yet identified) have not previously been observed in the asteroid belt. Past work with HST has shown that high resolution is crucially important for understanding the properties of the active asteroids. Here, we seek 2 orbits of Target of Opportunity time so that we can quickly respond to a new active asteroid discovery, obtain an initial assessment of its properties and rates of change, and then make an evidence-based decision about the need for requesting more time in order to understand the object.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Solar System Astronomy

ID: 16309

Program Title: Long-Period Comet C/2017 K2

Principal Investigator: David Jewitt

PI Institution: University of California - Los Angeles

Extraordinary long-period comet C/2017 K2 offers our best opportunity to study the rise of activity in a body entering the solar system from Oort cloud distances. Active initially at 26 AU, the comet is now near 8 AU and will approach the nominal distance for the onset of water ice sublimation by the end of Cycle 28. We seek HST observations 1) to measure the 3D morphology of the coma and to search for jet activity associated with local crystallization 2) to photometrically isolate the nucleus from its massive coma background and so to estimate its size and 3) to contribute to a unique record of cometary development from the largest distances. Already active when first detected beyond Uranus, K2 will cross both the crystallization zone (10 AU) and the water ice sublimation zone (5 AU) on its way to perihelion at 1.8 AU in late 2022. It is predicted to exceed naked-eye visibility and will be subject to increasingly intense astronomical study using the full range of techniques and wavelengths. It offers a unique opportunity to understand the degree to which comets evolve even before entry into the terrestrial planet region where they are more normally studied.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Solar System Astronomy

ID: 16310

Program Title: Interstellar Comet 2I/Borisov

Principal Investigator: David Jewitt

PI Institution: University of California - Los Angeles

C/2019 Q4 (Borisov) is the first interstellar comet and only the second interstellar object (after 'Oumuamua) ever identified within the solar system. We propose high resolution observations with WFC3 and HST in order to probe the development of this body in Cycle 28. During this time we will use HST and WFC3 to constrain the nucleus and dust properties. Observation as the Earth passes through the projected orbit plane early in the Cycle will provide a model-free estimate of the dust extent and velocity perpendicular to the plane. Additional, spaced observations provide perspectives as the object recedes from about 9 to about 13 AU. The high resolution of HST is needed to resolve faint near-nucleus structures (jets, fans) and fragments at the growing distance to the comet. The proposed observations extend the temporal coverage of the evolution of this unique object and take advantage of new perspectives.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Solar System Astronomy

ID: 16311

Program Title: The Next Interstellar Object

Principal Investigator: David Jewitt

PI Institution: University of California - Los Angeles

The recent detection of 1I/'Oumuamua and 2I/Borisov has opened the door to the study interstellar objects in the solar system. In both cases, astronomers scrambled to react to the new objects, in the process losing valuable time. We here propose a proactive, four-orbit Target-of-Opportunity program to make a rapid assessment of the next-discovered interstellar object. The aim is to quickly characterize the body so that the best possible follow-up studies can be planned. We will acquire observations to assess the coma, if one is present, and to determine whether the nucleus can be isolated within it using an established convolution modeling technique. The program also provides an initial assessment of the short-term variability. We propose an exclusive access period of 0 months so that these observations can be used by the community to plan the best possible observational studies of the new object.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Large Scale Structure of the Universe

ID: 16269

Program Title: Tension at the Breaking Point: Uncovering New Physics Through a Two-Rung Distance Ladder Measurement of the Hubble Constant

Principal Investigator: David Jones

PI Institution: University of California - Santa Cruz

Tension in the Hubble constant (H_0) is reaching the point of no return, with nearly a dozen re-analyses and semi-independent measurements confirming that the present rate of cosmic expansion is faster than expected given early universe observations and the LambdaCDM model. The most precise values of H_0 measured using the local distance ladder are now discrepant at the 4.4-sigma level with those inferred from the early universe. The H_0 tension is by far the most convincing current evidence for physics beyond LambdaCDM, and could indicate dynamical dark energy, self-interacting neutrinos, or a new relativistic particle, among other possibilities.

Only one component of the distance ladder still lacks sufficient independent verification: Type Ia Supernova (SN Ia) distances. It is imperative that we test this final rung of the ladder before declaring a discovery of new physics. We propose a new survey to obtain Cepheid distances for five highly star-forming galaxies in the Hubble flow to build a two-rung distance ladder without SNe Ia that will be able to measure H_0 with 3.2% uncertainty and, if the measurement agrees with current estimates, could verify H_0 tension at the 3-sigma confidence level. Our sample galaxies are also SN Ia hosts, allowing these observations to increase the precision of the baseline distance ladder method. Unlike current approaches, this new avenue to refine H_0 is not limited by the low rate of SN Ia in the local volume. This program will therefore open a new window to achieving the highest priority science goal identified by the HST and Fundamental Physics Working Group: the best possible measurement of H_0 in the remaining years of HST.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16296 |
| Program Title: | Bands of brothers: detecting banded structures in the atmospheres of Luhman 16A and B |


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| Principal Investigator: | Theodora | Karalidi |
| PI Institution: | University of Central Florida | |



To date three brown dwarfs in the L/T transition show signs of planetary-wave light-curve beating. Here, the differential rotation of wave-derived structure in various latitudinal bands causes their individual light curves alternately to constructively and destructively interfere. Luhman 16AB is an intriguing target, with both components exhibiting peculiar behaviors that hint to the existence of bands in their atmospheres. Recently, indirect evidence for bands on Luhman 16A were found using polarization. However, no data exists to date that is able to verify the existence of bands on 16A or B. We propose to observe Luhman 16AB with WFC3 to test the existence of bands in these two L/T transition brown dwarfs. Our observations will 1) test the hypothesis that there are planetary-scale waves and bands in L/T transition atmospheres, 2) verify the ability of polarization to detect bands in exoatmospheres, and 3) nearly double the sample of long-temporal-baseline observations available to detect planetary-scale waves in L/T transition brown dwarfs.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16312 |
| Program Title: | EFFECTS OF RECENT PERIASTRON PASSAGE AND ECLIPSE IN THE SYMBIOTIC SYSTEM R AQR |


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| Principal Investigator: | Margarita | Karovska |
| PI Institution: | Smithsonian Institution Astrophysical Observatory | |



We propose HST/WFC3 observations of the R Aqr symbiotic system, with joint Chandra and VLA observations, to carry out a high-angular resolution multiwavelength study of the binary environment and of the spatial and spectral characteristics and propagation of the ejecta resulting from the recent - earlier than expected - periastron passage of the WD accretor. The proposed observations follow up on the 2019 to early 2020 DDT/ToO HST+Chandra+VLA observations which show dramatic changes within 1" from the central binary since 2018, including newly ejected material obscuring the evolved Mira-type star and formation of a new jet. The observations are critical for studying the effects of the WD periastron passage, which include enhanced accretion and mass/jet ejections in this nearby symbiotic binary. These phenomena are observable only about twice a century, with the next periastron expected in about 40 years.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16180

Program Title: Constructing the First Spectroscopic, Multi-Dimensional Map of a Hot Jupiter

Principal Investigator: Tiffany Kataria

PI Institution: Jet Propulsion Laboratory

Eclipse mapping is an observational technique that uniquely measures an exoplanet's thermal structure as a function of both latitude and longitude. Multiwavelength eclipse maps provide an unprecedented view of a planet's three-dimensional dynamics, thermal structure, chemistry, and energetics. Here we propose to produce the first spectroscopic eclipse map of an exoplanet via observations of the best-studied hot Jupiter, HD 189733b, from 1.1-1.7 microns with WFC3/G141. These observations will measure the geographic distribution of dayside emission over these wavelengths, thereby constraining the global circulation patterns and relevant atmospheric timescales in HD 189733b with latitude, longitude and altitude. When combined with published Spitzer/IRAC mid-IR photometric phase curves and eclipse maps, our proposed WFC3 spectroscopic eclipse maps will paint the most detailed and complete picture to date of weather deep in a hot Jupiter atmosphere, refining general circulation models that aim to predict their climate. In addition, our proposed eclipse mapping observations will serve as the foundation upon which future observational and theoretical frameworks will interpret future spectroscopic eclipse maps with HST and of considerably smaller and cooler planets with JWST.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Large Scale Structure of the Universe

ID: 16134

Program Title: DOLPHOT for Time-Domain Astronomy

Principal Investigator: Patrick Kelly

PI Institution: University of Minnesota - Twin Cities

The optimal approach to measuring the flux of a transient object present in a Hubble Space Telescope (HST) image is to subtract a deep pre- or post-transient image, and extract the transient's flux measurement from the resulting difference image. DOLPHOT is the most powerful and widely used software tool to measure stellar photometry in HST imaging. Currently, however, DOLPHOT cannot be used to measure the fluxes astrophysical transients from difference imaging, despite its powerful capabilities. Here we propose to develop Python tools that will make it possible to use DOLPHOT to extract light curves from difference images constructed from WFPC2, ACS WFC, and WFC3 data. The package will provide a powerful new tool for time-domain astronomy with HST.

From our tests of field stars, we have found that DOLPHOT photometry is superior to point-spread function (PSF)-fitting photometry measured using currently available tools for time-domain astronomy. The capabilities of DOLPHOT absent from other time-domain packages include: 1) the ability to measure the flux of sources in individual exposures, 2) determination a PSF model for each HST visit, and 3) the ability to fit simultaneously multiple, overlapping variable point sources. Time-variable sources including multiply imaged quasars and supernovae as well as extremely magnified stars that have small separations on the sky require fits to overlapping point spread functions. The new capabilities provided by DOLPHOT will enable optimal extraction of photometry of transients, including Type Ia supernovae and the counterparts of compact-object mergers.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Exoplanets and Exoplanet Formation |
| ID: | 16135 |
| Program Title: | Quantifying the Effects of Host Star UV Scaling Relationships on Photochemical Modeling of Exoplanet Atmospheres |


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| Principal Investigator: | Eliza | Kempton |
| PI Institution: | University of Maryland | |



Photochemical models are necessary to predict and interpret the primary properties of exoplanet atmospheres (e.g. chemical composition, thermal structure, and aerosol production). This type of modeling is especially critical for understanding the many cool and low-mass exoplanets that will be discovered by TESS and characterized by HST and JWST, for which chemical equilibrium is a poor assumption. The UV spectrum of the host star is a key input to photochemical models. Unfortunately most exoplanet hosts have not had their UV properties characterized, and the prevailing M dwarf hosts are known to have especially diverse UV spectra. In the absence of UV observations of individual stars, scaling relations can be used to reconstruct their approximate UV spectra as inputs into photochemical models. However, the level of uncertainty introduced by using such scaling laws has not been quantified.

With this proposal we will determine for the first time the necessary level of precision and wavelength coverage for UV observations of exoplanet host stars to be used as input to photochemical calculations. We will do this by employing existing HST spectra of exoplanet host stars to generate photochemical models of low-mass exoplanet atmospheres using the publicly available code PHOTOCHEM. We will measure the errors introduced into such models by adopting UV scaling relations and/or low-precision input spectra. As a result of this work, we will identify any critical gaps in the complement of HST UV spectra of exoplanet hosts to enable the highest impact science for low-mass exoplanets in the era of JWST and ground-based ELTs.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16286

Program Title: The First Double Helium White Dwarf LISA Verification Source

Principal Investigator: Mukremin Kilic

PI Institution: University of Oklahoma Norman Campus

We propose to obtain low resolution ultraviolet spectroscopy of the newly identified 1201 s orbital period detached binary J2322+0509. This is the third shortest-period detached binary known, and it contains two He-core white dwarfs at a ~27 degree inclination. The low-inclination results in no visible photometric effects (e.g., eclipses, ellipsoidal variations), but makes this one of the strongest sources of gravitational waves in the mHz frequency range. Located 760 pc from the Sun, this binary has an estimated LISA 4-yr signal-to-noise ratio of 40. J2322+0509 is the first He+He white dwarf LISA verification binary, a source class that is predicted to account for one-third of all LISA ultra-compact binary detections. Here we request HST STIS observations in the far-ultraviolet to constrain the physical parameters of this binary precisely. The optical data on this system reveals about 15% contribution from the cooler secondary white dwarf, limiting the precision of our model atmosphere analysis on the primary white dwarf. The primary star is hot, and it dominates in the far-ultraviolet. Our STIS data will enable us to constrain the temperature and mass of the primary precisely, which in turn will constrain the radius and mass of the secondary star, and the inclination of the system. Well-measured white dwarf binaries will be among the best electromagnetic + gravitational wave laboratories for understanding the formation of compact objects, dynamical interactions and tides in binaries. J2322+0509 is one of the best such systems.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16136 |
| Program Title: | Using the full power of the HST Archive to Address the Red Supergiant Problem |


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| Principal Investigator: | Charles | Kilpatrick |
| PI Institution: | University of California - Santa Cruz | |



Recent studies cast doubt on whether the most massive red supergiants can successfully explode as Type II supernovae. However, these studies rely on populations of red supergiants that do not include pre-explosion constraints on recently discovered Type II supernovae or the full volume of such imaging in which distant red supergiant progenitor stars might be detectable. We want to address this problem by conducting a complete, volume-limited analysis of all Type II supernovae within 60 Mpc that have pre-explosion HST imaging, totaling 68 sources. This analysis will more than double the current sample of such supernova progenitor constraints, leading to much larger statistical sample with which we can better analyze the possibility of "missing" red supergiants. In particular, recent work suggests that if red supergiants are missing due to implosion as "failed supernovae", then red supergiants in other mass ranges should also be underrepresented relative to a typical Salpeter initial mass function. With better statistics, we can test this hypothesis and better understand the evolutionary pathways and final fates of massive stars.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Supermassive Black Holes and AGN |
| ID: | 16137 |
| Program Title: | Obscured CANDELS: Disentangling Obscuration around Supermassive Black Holes in the Distant Universe |


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| Principal Investigator: | Allison | Kirkpatrick |
| PI Institution: | University of Kansas | |



Many active galactic nuclei (AGN) in the distant universe (z=1-3) are obscured, although the source of this obscuration is unclear. Obscuration can arise from the AGN torus or from the host galaxy, but distentangling these is difficult. We propose to reanalyse HST ACS and WFC3 images of X-ray selected AGN in the CANDELS legacy survey. We will decompose AGN images into a point source and host galaxy and model the resulting spectral energy distributions to obtain the attenuation in the host and AGN, separately. We will correlate the host and AGN obscuration with galaxy properties SFR, stellar mass, and stellar mass surface density. Our sample spans a wide range of stellar mass (log Mstar = 9.5-12.5 Msun) and X-ray luminosity (log LX = 42 - 45 erg/s), so we will measure whether most AGN in the distant universe go through an obscured phase prior to galaxy quenching.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Supermassive Black Holes and AGN

ID: 16241

Program Title: A NUV Snapshot Survey of the Nearest Luminous AGN

Principal Investigator: Michael Koss

PI Institution: Eureka Scientific Inc.

Nearby powerful AGN provide the best way to understand the growth of supermassive black holes and their effect on galaxies. The Swift-BAT 105-month survey, with its all-sky coverage that is insensitive to obscuration up to Compton-thick levels, provides the largest, most complete sample of local (z<0.1) powerful AGN. These AGN have similar luminosities to the distant AGN typically found in deep, pencil-beam Chandra surveys and are thus a critical nearby template for luminous high-redshift AGN. Despite containing the most luminous nearby AGN, only five have have been imaged in the NUV. We propose a snapshot (SNAP) near UV survey (NUV, <3000A) in the F225W filter of the 124 nearest and X-ray brightest AGN with black hole mass measurements from broad line Hbeta with existing V or I-band HST imaging. These sources only have NUV imaging with Swift/UVOT or XMM-Newton/OM where the spatial-resolution is 30x coarser and thus nuclear star formation and PSF emission are impossible to accurately separate. These ~100 pc resolution observations will resolve the power output of local AGN and study the link of nuclear star formation with AGN activity.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16181

Program Title: Exploring the Demographics of Exo-Neptunes: Atmospheric Characterization of a Cool Sub-Neptune from TESS

Principal Investigator: Laura Kreidberg

PI Institution: Smithsonian Institution Astrophysical Observatory

NASA's Transiting Exoplanet Survey Satellite (TESS) is rapidly discovering small transiting planets around the nearest and brightest stars that are most amenable to detailed follow-up characterization. One of the most exciting recent TESS discoveries is TOI 1231b, a 3.6 Earth radius planet orbiting an M- dwarf 27 parsecs away. This planet stands out thanks to its low equilibrium temperature - just 330 Kelvin. As the second temperate sub-Neptune accessible for atmosphere studies, TOI 1231b occupies a poorly explored region of parameter space and can help break the degeneracy in demographic trends in the exo-Neptune population. We propose to observe (1) the transmission spectrum of TOI 1231b in the near-infrared and (2) the Mg II emission from the host star in the UV. With these data, we will be able to detect spectral features at high confidence for a realistic, 100x solar metallicity atmosphere, even if high altitude clouds are present. In addition, our UV observations will provide a critical missing piece in the modeling of atmospheric photochemistry and interpretation of the planet's transmission spectrum. Taken together, these data will provide one of the first glimpses into atmospheric chemistry near the habitable zone, building an essential foundation for interpreting the spectra of potentially habitable planets when they are measured with future facilities.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Intergalactic Medium and the Circumgalactic |
| ID: | 16242 |
| Program Title: | The Baryonic Content of Galaxies Mapped by MaNGA and Gas Flows Around Them |


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| Principal Investigator: | Varsha | Kulkarni |
| PI Institution: | University of South Carolina | |



Galaxies interact with the intergalactic medium (IGM) through gas inflows and outflows that pass through the circumgalactic medium (CGM). Understanding how the gas in the galactic disk, bulge and halo couples with the CGM remains an important open question. Spatially resolved integral field spectroscopy of nearby galaxies from the SDSS IV MaNGA survey is revealing the structure and kinematics of the bulge and disk components in inner parts of galaxies. However, the MaNGA data offer little insight about the halos and CGM of these galaxies. Furthermore, the MaNGA data on ionized gas need to be complemented with measurements of the cool neutral gas, which reveals the role of accretion in the growth of galaxies. We propose to observe the cool gas in and around 14 nearby galaxies ($z < 0.1$) mapped with MaNGA by measuring absorption lines produced by the gas in spectra of background quasars/AGN at impact parameters of 0 to 25 effective radii from the galaxy center. Our specific goals are to (1) measure the cool-gas metallicity from absorption lines and compare to the ionized gas metallicity from MaNGA; (2) measure gas ionization based on ratios such as Si III/Si II; (3) examine how absorbing gas properties correlate with galaxy properties; and (4) compare the cool gas kinematics with ionized gas kinematics, e.g. does the cool gas lag behind the galaxy's mid plane as the ionized gas does. This is the first survey combining the power of absorption line spectroscopy with IFS for an exceptionally well-studied sample of nearby galaxies to determine the total baryonic content of galaxies and the gas flows around them. HST is essential due to the need for UV spectroscopy.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Solar System Astronomy |
| ID: | 16313 |
| Program Title: | Tracking the Uranian magnetosphere between solstice and equinox and the inner rotation rate of the planet |


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|---|---|---|
| Principal Investigator: | Laurent | Lamy |
| PI Institution: | Observatoire de Paris - Section de Meudon | |



This proposal aims at bringing our understanding of the Uranian magnetosphere, as the archetype of twin ice giant asymmetric magnetospheres, a step forward before the end of HST lifetime. We propose to track the UV (H and H2) aurorae of Uranus with STIS imaging at next opposition, while the planet lies between equinox and solstice. The observations will be carefully scheduled to sample variable solar wind conditions predicted by robust MHD codes throughout a validated methodology. The aurorae, predicted to be brighter and more spatially elongated than near equinox, will sample the ununderstood equinox-to-solstice configuration of the Uranian magnetosphere and the dynamical evolution from equinox to northern winter solstice. Such observations are crucial to resample and update the inner planetary rotation rate, a key parameter for understanding the planetary interior, and to define a valid SIII longitude system which will be required for any future spatial exploration of the planet. For this purpose, the aurorae will be accurately fitted by magnetic field models and cross-compared to the position of the magnetic poles derived previously to constrain the rotation rate at unprecedented accuracy.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16297

Program Title: Catching radio-mode feedback in action with COS UV absorption spectroscopy

Principal Investigator: Ting-Wen Lan

PI Institution: University of California - Santa Cruz

A widely accepted tenant of galaxy formation theory is that red-and-dead galaxies maintain their quiescent status through the sustained impact of radio-mode feedback. Driven by an active galactic nucleus, this feedback is purported to heat gas in the galaxy's surroundings to prevent the accretion and cooling of gas onto the galaxy. Moreover, radio-mode feedback drives gas outflows and may remove a substantive amount of gas from galaxies. While radio-mode feedback is now a nearly generic feature of numerical simulations of galaxy formation, the physical mechanisms that drive the interaction between radio jets/lobes and gas in galaxies are still poorly known. With this proposal, we will study a galaxy with bright radio jets (i.e. caught in the act) and therefore putatively exhibiting the radio-mode feedback that sustains its absence of star formation. Fortuitously, a UV luminous quasar lies background to this galaxy with its sightline intersecting the system at an impact parameter R ~ 4 kpc. Existing optical spectra of the quasar shows likely CaII absorption associated with the foreground galaxy, i.e. cool and dense gas. The proposed HST/COS observations will extend the analysis to a diverse set of diagnostics -- HI Lya, OI, SiII, SiIII, SiIV, CII, CIV -- to assess the metallicity, kinematics, and multi-phase nature of gas in the galaxy. These data will provide direct insight into the process of radio-mode feedback and offer tests for current and future models.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16265

Program Title: The ever-changing face of SN 1987A

Principal Investigator: Josefin Larsson

PI Institution: Royal Institute of Technology

SN 1987A is the great supernova (SN) of the HST era. An unbroken string of observations is the essential tool for detecting change and establishing a uniform legacy archive. Recent imaging has shown dramatic changes in the ejecta and the interaction with the circumstellar material. After a steady increase in flux, the inner circumstellar ring reached a maximum in 2009 and is now fading rapidly as it is destroyed by shocks. At the same time, diffuse emission and new spots outside the inner ring are becoming visible, gradually revealing previously unseen material that extends toward the outer rings. Monitoring this emission is required to understand the formation of the rings and the mass-loss history of the progenitor star. In addition, the expanding innermost ejecta reveal asymmetries and mixing in the explosion. As the ejecta expand, X-rays from the inner ring penetrate into the metal-rich core, which results in a brightening in the optical band. We request imaging in narrow and broad filters over the next three cycles to follow these developments. Annual observations are needed to monitor the rapid evolution of the shocks. Imaging in additional filters in one of the cycles will provide flux measurements crucial to estimating the energy budget of the ejecta, that, perhaps, will begin to reveal the elusive compact object. The HST observations have a unique blend of photometric fidelity and angular resolution that make them the indispensable partner to ongoing X-ray, sub-mm ALMA, and ground-based optical/NIR observations. They are also an important complement to the JWST GTO observations in 2022.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Large Scale Structure of the Universe |
| ID: | 16138 |
| Program Title: | Constraining the masses of galaxy overdensities at z > 1 in CANDELS and COSMOS through weak lensing in the NIR |


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| Principal Investigator: | Bomee Lee |
| PI Institution: | California Institute of Technology |



Measuring weak gravitational lensing (WL), a powerful probe of the distribution of dark matter, is one of the primary science goals of the next decade of large extragalactic surveys with LSST, Euclid, SKA and WFIRST. Currently, however, the WL analysis has primarily been on optical-band data (e.g. HST/ACS, DES, and HSC-SSP). Near-infrared (NIR) imaging has thus far never been used for wide-field weak lensing measurement although it is now well-known that it provides superior galaxy shape measurements at z > 1 due to morphological k-correction. We propose an archival study to present the first galaxy shear catalog with the largest set of archival NIR images from the two widest HST/WFC3 surveys: CANDELS and COSMOS-DASH. Our program will aim to 1) test the fidelity of the resultant NIR WL map of dark matter in COSMOS with existing, optically- derived maps, 2) reveal galaxy over-densities at z > 1 in clusters/groups which are otherwise unknown due to photometric redshift uncertainties, 3) derive stellar/baryonic to dark matter mass ratios at z >1. Measuring these ratios on group and low-mass cluster scales will trace the relationship between the growth of large scale structure and the buildup of stellar mass thereby allowing a more complete understanding of galaxy evolution, and comparison with cosmological models over a relatively understudied redshift range. Due to the exceptional depth and spatial resolution of HST, and by leveraging the current state-of-the-art understanding of NIR detector/PSF systematics, our program will serve as a critical stepping stone for NIR WL science in upcoming surveys, with Euclid and WFIRST.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16298

Program Title: Enhancing the astrometric legacy of HST for globular clusters

Principal Investigator: Mattia Libralato

PI Institution: Space Telescope Science Institute

Fifteen years ago, the ACS Survey of Galactic Globular Clusters (GO-10775) imaged the cores of 66 Galactic globular clusters to construct a uniform database of deep V and I photometry in hopes of tying up the few loose ends that remained in these simple populations. At the time of the survey, we were just beginning to understand that globular clusters do not consist of simple single populations but rather are made up of complicated multiple populations (mPOPs).

Since this initial survey, clusters have been studied intensely by HST to understand the mPOP phenomenon. Unfortunately, the UV-focused nature of the mPOP studies meant that the new observations rarely matched the depth of the original survey. As a result, proper motions for stars in different mass groups could not be measured.

This is a SNAP proposal to obtain deep second-epoch observations in the cores of the 44 of the original 66 clusters for which there is inadequate archive data. By measuring proper motions for stars in different mass groups along the main sequence, we can properly probe the dynamical state of each cluster in terms of equipartition, anisotropy, etc. This goal is perfect for a SNAP program, since the clusters are spread across the sky and we do not need to measure colors for the stars. We simply need see where the stars are today relative to where they were in 2006, with observations that are almost perfectly matched to the first-epoch ACS data.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16139

Program Title: A Grid Idea: A New Comprehensive Self-Consistent Radiative-Convective Model Grid for Exoplanet Atmospheres

Principal Investigator: Michael Line

PI Institution: Arizona State University

Transit spectroscopy with HST (and upcoming JWST) pioneered our understanding of extra-solar planet atmospheres spanning ultra-Hot Jovian worlds to temperate super-earths. This vast planetary diversity leads to many key questions about the nature of planetary climate, composition, and chemistry. Questions regarding the processes influencing molecular abundances, intrinsic elemental composition, and heat transport as well as many others can only be addressed via the interplay between spectral data and atmospheric models. We propose to develop a new large, publicly available, 1D self-consistent radiative-convective equilibrium spectral model grid to advance our understanding of broad planetary atmosphere population trends and to perform Bayesian atmospheric parameter estimation. This new grid will be applied to published and archival HST spectrophotometric transit observations composed of more than 1000 HST orbits over wavelengths covered by STIS, WFC3, and soon UVIS, (as well as countless hours with Spitzer) obtained over the past two decades. Results from this investigation will be used to make predictions for both upcoming HST and JWST spectra for specific planets and also population level predictions in uncharted parts of the planetary phase space where new observations will provide maximal hypothesis discriminating power.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16210

Program Title: Spectroscopic Confirmation of High-Redshift Close Dual/Lensed Quasars from Gaia and HST

Principal Investigator: Xin Liu

PI Institution: University of Illinois at Urbana - Champaign

Dual quasars are expected to be common in the hierarchical structure formation paradigm. Despite their significance, no confirmed dual quasar is known with <10 kpc separations at 1<z<3, in stark contrast to theoretical expectations. We propose STIS (G750L) slit spectroscopy for 14 double-core quasars to systematically discover close dual or lensed SMBHs at redshifts 1<z<3 for the first time. Our sample probes a new regime at higher redshifts and smaller merger separations than previous work - crucial for understanding the significance of mergers in triggering quasar activity in the cosmic "high noon". Our targets are selected using the new astrometric technique: when two close-by AGN vary stochastically, their combined light centroid shifts, which is detectable by Gaia. Follow-up HST imaging of Gaia-selected targets has uncovered double-cored morphology with nuclear separations of ~0.3"-0.6". The proposed STIS spectra will reject interlopers such as chance superpositions with stars/galaxies to unambiguously confirm the targets as dual or lensed quasars. The results will provide empirical constraints on the merger rate of supermassive black holes and therefore on the stochastic gravitational wave background from binary supermassive black holes.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Intergalactic Medium and the Circumgalactic

ID: 16140

Program Title: What Holds Up the CGM?

Principal Investigator: Cassandra Lochhaas

PI Institution: Space Telescope Science Institute

The standard paradigm of galaxy evolution assumes the circumgalactic medium (CGM) is primarily composed of hot gas in hydrostatic equilibrium (HSE) within the gravitational potential of the galaxy's halo. However, COS observations challenge this paradigm by finding a larger quantity of cool gas in the CGM of L* galaxies than expected. Recent analytic models that reconcile the cool gas mass budgets with the assumption of HSE are in tension with CGM simulations, which show large deviations from HSE driven by inflows, outflows, and turbulence. A successful model of the CGM will thus need to account for the contribution of these motions, not just gas pressure, to its long-term dynamic equilibrium. We propose developing a new CGM support model based on quantified contributions of outflows, accretion, and turbulence to the overall support of gas, rather than imposing HSE. We will use the high-resolution Figuring Out Gas & Galaxies in Enzo (FOGGIE) zoom-in simulations to identify spatially distinct regions of the CGM (e.g. outflows vs. accretion) and characterize turbulent motions and rotation. We will determine how the dynamical equilibrium of CGM gas depends on physical properties of galaxies, including outflow rate, accretion rate, redshift, and halo mass. We will perform a controlled experiment by repeating the full analysis on a restarted FOGGIE run with elevated feedback. For all runs we will use synthetic absorption spectra to explore how the flows that hold up the CGM against gravity are reflected in the observations. The new model and synthetic data together will be directly applicable to the interpretation of past and future COS quasar absorption line spectra.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Galaxies |
| ID: | 16141 |
| Program Title: | A New Angle on Attenuation: Investigating Dust and its Relationship to Galaxy Inclination |


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| Principal Investigator: | Brian | Lorenz |
| PI Institution: | University of California - Berkeley | |



Nearly all observations of distant galaxies must account for the effects of dust, yet we do not fully understand what drives variations in dust attenuation. Dust attenuation is commonly measured by observing its effect on emission lines (e.g., Balmer decrement) or by observing overall stellar attenuation. Both locally and at high-redshift, studies find that the difference between these two measurements varies among galaxies. The varying differential attenuation is often explained by hot and cold dust components and complex dust-to-star geometry, but it is still subject to debate. Furthermore the dust attenuation curve is found to vary among different galaxies. The origin of this variation is also unclear and might be related to the variations found for the differential reddening. Recently, Battisti et al. (2017) explored a new avenue and found a strong correlation between the differential reddening and axis ratio (i.e., viewing angle) in low-redshift galaxies. We propose to use a similar approach and investigate variations in attenuation properties for distant galaxies using a unique combination of HST archival and other datasets. Through a novel clustering analysis technique, we will stack galaxies to create deep spectral energy distributions with high spectral sampling. Together with MOSDEF spectra for 1100 galaxies, we will measure attenuation curves and Balmer decrements and relate them with viewing angles from deep HST imaging. We will also explore the relations between dust and galaxy properties, including specific SFR and metallicity. Consequently, this work will address pressing questions about the distribution and effects of dust in distant galaxies.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Physics and Stellar Types

ID: 16142

Program Title: The First Grid of White-Dwarf-Irradiated Brown Dwarf Atmosphere Models

Principal Investigator: Joshua Lothringer

PI Institution: The Johns Hopkins University

Highly irradiated brown dwarfs (BDs) provide essential tests to models of brown dwarf atmospheric physics. While only a handful have been discovered, BDs in ultra-short period orbits around white dwarfs (WDs) are a physically interesting and observationally favorable class of irradiated substellar objects, reaching equilibrium temperatures matching or exceeding their internal heat. Recently, HST Program 15947 was approved to execute the first survey of such objects. Currently, however, no self-consistent BD atmosphere models exist that take into account the extreme UV irradiation from a WD host. We propose to calculate the first grid of self-consistent atmosphere models and synthetic spectra for Program 15947's six targets to strengthen the theoretical expectations for how the atmosphere's of these informative objects behave under such extreme conditions. We will investigate the interplay between extreme irradiation and high internal heat, as well as the sensitivity of emergent spectra to intrinsic properties like the internal temperature, efficiency of heat transport, albedo, surface gravity, and metallicity. The grid will also enhance the interpretation of other existing HST datasets, including observations of two brown dwarfs around main-sequence stars and the large collections of hot Jupiter and isolated brown dwarf spectra. Future observations with JWST of these various classes of substellar object will also benefit from this investigation.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Exoplanets and Exoplanet Formation |
| ID: | 16270 |
| Program Title: | Heavy Metal Bands: A Study of Escaping Ions from the Hottest Jovian Atmospheres |


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| Principal Investigator: | Joshua | Lothringer |
| PI Institution: | The Johns Hopkins University | |



HST is the only facility capable of probing the uppermost planetary layers in the ultraviolet, which is key to understanding and modeling the vigorous atmospheric mass-loss seen in highly irradiated exoplanets. Recent HST NUV observations of an ultra hot Jupiter (UHJ) have definitively shown that ionized heavy elements including iron and magnesium are driven by atmospheric escape beyond the Roche lobe. These observations indicate the gas is not gravitationally bound to the planet, resulting in enormous signals when seen in transit. These ionized species may be hydrodynamically escaping or could be magnetically confined to the planet. Here we propose to observe escaping ions from the atmospheres of two ultra-hot Jupiters orbiting two of the most UV-bright exoplanet host stars. By observing in the NUV, we can compare the escape rates of heavy elements, measure the velocity profiles, and determine the extent to which the Roche lobe is filled of several UHJs orbiting different spectral type host stars, thus testing mass-loss mechanisms across differing XUV irradiation levels. We will also search for asymmetries in the NUV transit light curves, which will constrain post-cometary evaporation tails and magnetically controlled outflow.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Stellar Physics and Stellar Types

ID: 16287

Program Title: A public UV snapshot survey of core-collapse supernova hosts in IFS data

Principal Investigator: Joseph Lyman

PI Institution: The University of Warwick

We propose a public UV survey of core-collapse supernova (CCSN) host galaxies to provide environmental insights into their progenitor systems. Understanding the progenitors of core-collapse supernovae (CCSNe), the explosive deaths of massive stars, is vital to our understanding of the chemical and dynamical evolution of the baryonic Universe, and the production channels for compact merger gravitational wave sources. Our knowledge of how progenitor properties (e.g. initial mass, multiplicity, metallicity) translate to the empirical CCSN subclasses is sorely lacking. Despite surges in CCSN discoveries, direct progenitor constraints are elusive, and so environment and host galaxy studies, through analysis of the coeval stellar populations, offer valuable alternate routes to perform large-scale population studies. UV coverage is uniquely afforded by HST and a key window into star formation and massive stellar populations. Crucially, the targets have been selected by having pre-existing integral-field spectroscopic (IFS) observations. Galaxy studies have undergone a resurgance with the advent of new IFS instruments, allowing spatially-resolved spectroscopic studies across entire galaxies, but suffer from a lack of wavelength coverage. The UV data proposed is essential to derive meaningful properties of young stellar populations. This will provide the age resolution in stellar population fitting to, for the first time, directly measure the delay-time-distribution of CCSNe and assess the relative contribution of binary progenitors. Such a data set will have legacy for a multitude of galaxy studies and we are commited to making our joint UV+IFS dataset and analysis public.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Supermassive Black Holes and AGN |
| ID: | 16143 |
| Program Title: | Stellar Torques and Gas Flows in Galactic Centers: Feeding and Feedback in Nearby Active Galactic Nuclei |


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| Principal Investigator: | Matthew Malkan |
| PI Institution: | University of California - Los Angeles |



Measuring the fueling and feedback in active galactic nuclei is vital to understanding the co-evolution of galaxies and their massive black holes. We have 0.1" resolution ALMA CO spectroscopic maps of the velocity fields of molecular gas in and around the centers of a representative sample of 48 nearby (d<50Mpc) AGN. We model the rotation with Diskfit revealing residuals from circular motion due to gas inflows and outflows.

We propose combining ALMA velocity maps with three observables available only from HST imaging: 1) red starlight to determine the distribution of stellar mass, which determines the gravitational potential; 2) color maps of absorption lanes to show the distribution of dust; and 3) continuum-subtracted narrow-band images of H-alpha+[NII] and [OIII] to measure the distribution of ionized gas.

As demonstrated on a few galaxies, this combination of HST measurements of the stellar mass with ALMA velocity fields maps the distribution of stellar torques on gas. Where they are negative, gas flows inward, with a mass rate which we calculate. We will determine if these inflows account for the AGN accretion rate derived from bolometric luminosities; and if gas depletion timescales are comparable to AGN duty cycles. Where we detect outflows, HST images will show their impact on star formation.

Our 48-galaxy sample will reveal correlations between gas inflow and outflow properties with the mass and accretion rate of the MBH, the presence of broad lines (direct or hidden), and properties of the host galaxy. We will test predictions that outflow energies are 5% of AGN luminosity. We will also perform this HST+ALMA

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16314

Program Title: Investigating extreme evolved planetary systems: The hottest white dwarf debris disc

Principal Investigator: Christopher Manser

PI Institution: The University of Warwick

There is vast evidence establishing the survival of exoplanets through the evolution of their host stars into white dwarfs (WDs). A key signature that betrays the presence of planetary systems around WDs is a compact (~ 1 Solar radius) debris disc, formed from the tidal disruption of planetesimals and detectable as an infrared flux excess. These discs accrete onto the WDs polluting their otherwise pristine H or He atmospheres, and the analysis of adequate optical and UV spectroscopy of these systems allows reconstruction of bulk composition of the disrupted planetesimals.

A rare subset of debris discs host gas that can be observed through double-peaked emission profiles, tracers of "fresh" disruption events which provide dynamical and geometric information on the disc. In a search for debris disc hosts we have identified the gaseous debris disc host, WD J2100+2122. The WD has an effective temperature of 26760 K, making it by far the hottest gaseous debris disc host known to date and challenges the standard model of debris discs. The emission profiles from the disc are unusual; where all known gaseous debris discs are dominated by the 860nm Ca triplet emission, the spectrum of WD J2100+2122 exhibits an array of Fe emission features.

The peculiar emission features can either be explained by (i) the high temperature of the WD heating the disc and thereby changing the line strengths, or (ii) the composition of the accreted body being Fe-enhanced/Ca-depleted. To determine the correct scenario, we require a single orbit of COS spectroscopy to fully characterise the elemental abundance of the accreted planetesimal using the plethora of absorption lines

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Exoplanets and Exoplanet Formation |
| ID: | 16168 |
| Program Title: | Stuck in the Middle with WASP-77Ab: Defining Transitions in Hot Jupiter Atmospheres |


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| Principal Investigator: | Megan | Mansfield |
| PI Institution: | University of Chicago | |



Hot Jupiters are compelling targets for thermal emission observations because their high signal-to-noise allows precise atmospheric characterization. Theory predicts a continuum of thermal structures and resulting emission spectra for these objects. Planets with dayside temperatures (Tday) below ~2100 K are expected to have uninverted atmospheres and display absorption features in their spectra. Planets with Tday>2100 K should have inverted atmospheres, but only those with 2100<Tday<2500 are expected to show emission features, as those with Tday>2500 are expected to have featureless, blackbody-like spectra. While we have observed cooler planets with absorption features and warmer planets with blackbody-like spectra, we have not observed any intermediate-temperature planets at high enough precision to understand the transition between these regimes.

We propose to use the Hubble Space Telescope (HST)/WFC3+G141 grism to observe the thermal emission spectrum of the hot Jupiter WASP-77Ab. WASP-77Ab planet sits at a temperature where the models predict the widest range of potential atmospheric structures and resulting secondary eclipse spectra, and it is the only planet in this transition region whose spectrum can be measured precisely with only two eclipse observations. The resulting spectrum will be as precise as that of the benchmark hot Jupiter WASP-43b, and if it shows absorption or emission features we will place equally tight constraints on the water abundance of WASP-77Ab. Its high signal-to-noise means WASP-77Ab has the potential to become a new archetype hot Jupiter and will likely be targeted for extensive JWST observations if its spectrum shows interesting features.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Galaxies

ID: 16257

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

Principal Investigator: Francine Marleau

PI Institution: Universitat Innsbruck, Institut fur Astronomie

As part of a systematic deep imaging survey with MegaCam/CFHT, 91 ultra-diffuse galaxies (UDGs) in low to medium density fields have been identified. This UDG dataset is among the largest sample of this type of galaxy outside of galaxy clusters. Thanks to the high image quality of MegaCam, part of their globular clusters (GCs) population can already be detected and a sub-sample of UDGs with an apparent excess of such point sources have been identified. For one of them, a large fraction of the GCs was confirmed with follow-up VLT/MUSE spectroscopy. Strikingly, they appear as being over-luminous with a luminosity one magnitude brighter than what is expected from the GC luminosity function (GCLF). Many of its properties, i.e., the number of GCs, the brightness of the GC population, and an apparent lack of dark matter, are similar to the heavily discussed UDGs NGC1052-DF2 and -DF4. Our HST mid cycle 27 proposal to identify the whole population of GCs in this UDG was recently approved and 3 UDGs have ACS archival data. We propose a SNAPSHOT program of the remaining 87 UDGs in low density fields, employing two-band ACS imaging to trace the full population of GCs 3 magnitudes below the peak of the GCLF. The HST observations, combining depth, color information, and superior image quality, will give us an accurate estimate of the total number of GCs. With that, we can characterize the GC systems of UDGs in low density environments and test whether some UDGs host an exceptionally large number of GCs, but with a regular GCLF, or contain a population consisting of only over-luminous GCs. Both cases pose a conundrum for our undertanding of GC and galaxy formation.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16243

Program Title: Determining the low-mass cutoff for star formation

Principal Investigator: Federico Marocco

PI Institution: Jet Propulsion Laboratory

With recent advances in the discovery of very low temperature brown dwarfs, we are now able to discern the shape of the low-mass end of the field mass function and define the low-mass cutoff itself. We propose to do this with a volume-limited (d < 20 pc) sample of the coldest known spectral types, Y dwarfs. Our multi-telescope campaign to obtain high-quality astrometry and photometry for this sample is well underway. HST is essential to complete the trigonometric measurement of parallaxes for the 14 faintest and coldest members of our sample. These are only accessible via HST. A combination of publicly available WISE and Spitzer data together with HST WFC3 F110W data will complete the distance and temperature determination for this sample. Having distances and temperatures for all of the coldest objects in the the Solar neighborhood provides an unprecedented look at the low-mass end of the mass function, and brings us one step closer to answering some of the most important questions in all of astrophysics: how can star formation create objects of extremely low mass? With what efficiency? Is there a low-mass cutoff to star formation?

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Stellar Physics and Stellar Types

ID: 16230

Program Title: An NUV SNAP program to supplement and enhance the value of the ULLYSES OB star legacy data.

Principal Investigator: Derck Massa

PI Institution: Space Science Institute

We propose a SNAP program to obtain NUV and blue optical spectrophotometry (1700 - 5700 Ang) of 200 Magellanic cloud OB stars in the ULLYSES sample. The new data will complete the HST UV coverage of the absolute flux calibrated ULLYSES sample and merge it with current and forthcoming optical data. The observations will complement and enhance the power and utility of the ULLYSES data. The proposed G230LB spectra will provide complete coverage of the 2175 Ang extinction bump and capture important spectral diagnostics that are absent in the current ULLYSES wavelength coverage for most stars. Supporting G430L spectroscopy will furnish critical temperature and surface gravity diagnostics that are essential to disentangle the slope of the UV extinction from stellar effects. These same data will also furnish powerful constraints for model atmosphere analyses. Finally, the new data will be a valuable addition to the ULLYSES spectral library since they will complete its UV coverage and include flux calibrated spectra of the Balmer jump and upper Balmer lines.

In the spirit of the ULLYSES program, we wave proprietary period so that the data will become immediately available to the community.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16299

Program Title: The Nature of a Newly Discovered Wolf-Rayet Binary: Archetype of Stripping?

Principal Investigator: Philip Massey

PI Institution: Lowell Observatory

Understanding massive star evolution is important for a variety of astrophysical processes, from the formation of the elements to the generation of gravitational waves as their remnants merge. Wolf-Rayet stars are evolved stars, where the hydrogen has been removed from a massive OB star, and its nuclear burning products revealed at the surface. This stripping can occur either by stellar winds or by interactions in close binaries. Although we expect the latter to be an important mechanism, there are few examples where one can argue which mechanism has been responsible, as even a single WR star may have formed through binary interaction, but merged with its companion. Given the large number of massive stars in binaries, we expect stripped remnants to be common. Binary models suggest these should look like WR stars, but they are curiously absent where we most expect to find them. However, the recent discovery of a WR binary in the LMC matches many of the properties expected for a stripped binary WR. We have obtained extensive ground-based photometry and spectroscopy of this object, and have carried the analysis as far as it is possible. The WR component is of WN4-type, but with intrinsic hydrogen and helium absorption lines. The companion is an "impossible" star, with a sub-solar mass and radius but a very high temperature. We suggest that this is the result of an Algol-like system, with both components having been donors and recipients at some point. This could be the archetype of binary-produced WRs, but we need UV spectra to determine CNO abundances, stellar wind properties, and better estimates of the bolometric luminosity. HST is the only way to achieve this.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16244

Program Title: Blue Lurkers: Low-Mass Blue Stragglers and the Stability of Mass Transfer

Principal Investigator: Robert Mathieu

PI Institution: University of Wisconsin - Madison

Mass transfer occurs in binary stars across stellar masses, and has broad implications for astrophysics. Binary evolution with mass transfer leads to gravitational wave sources, SNe Ia's, low mass X-ray binaries, sub-dwarf O/B stars, blue stragglers, and assuredly new objects in the LSST-era.

Mass transfer physics remains uncertain in crucial ways, one being the relative frequency of stable Roche-lobe overflow (RLOF) and unstable common-envelope (CE) evolution. Theory argues that the fork between RLOF and CE depends on binary mass ratio; higher mass ratios go through CE evolution.

Blue stragglers are tracers of the evolution of solar-like binary stars with orbital periods of less than 10,000 days. HST discovery of white dwarf (WD) companions showed that most open cluster blue stragglers form via RLOF onto secondary stars near the main-sequence turnoff mass.

We propose to study blue stragglers with masses below cluster turnoffs, specifically the recently discovered blue lurkers in the 4-Gyr open cluster M67. Formed from binaries with higher mass ratios, these blue lurkers can empirically define the RLOF/CE stability criterion.

We will search for hot WD companions in the blue lurker binaries using ACS/SBC FUV photometry, and determine their formation times from cooling ages. Discovery of WDs would establish that blue lurkers also have predominantly stable RLOF origins. Their larger progenitor mass ratios then provide new guidance for

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Intergalactic Medium and the Circumgalactic

ID: 16288

Program Title: What governs the physics of the warm-hot circumgalactic medium?

Principal Investigator: Smita Mathur

PI Institution: The Ohio State University

The properties of the circumgalactic medium (CGM) are governed by the details of galaxy formation, evolution and feedback. The high ionization lines of OVI are the most effective probes of the warm-hot CGM of L* galaxies, because the ionization fraction of OVI peaks at the virial temperature of these galaxies. An important observational result in this field was published in Science; it showed that the prevalence and strength of the OVI lines depend on the specific star-formation rate (sSFR) of galaxies. However, there is a clear correlation between sSFR and stellar mass in the observed sample, so the governing parameter may be mass instead. Theoretical simulations are also providing conflicting results, therefore new observations are needed to inform the theory. We propose to probe the CGM of L* galaxies at a range of sSFR, but at fixed mass. We will thus determine whether mass or sSFR is the driving factor of CGM properties, or there is additional physics. This will be a major step forward in our understanding of the physics of gas inflows and outflows, star-formation and feedback, and their relation to halo mass. This small program will greatly enhance the scientific return on previous investments of hundreds of orbits by clearly distinguishing between the possible

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16258

Program Title: The Environment of the most distant Radio Loud Quasar

Principal Investigator: Chiara Mazzucchelli

PI Institution: European Southern Observatory - Chile

High-redshift luminous QSOs (z~6) already host billion solar masses black holes in their centers, and are predicted to live in high-density peaks of the dark matter distribution, surrounded by overdensities of galaxies. Previous searches for Lyman Alpha Emitters (LAEs) with narrow-band (NB) imaging around radio-quiet high-z QSOs did not recover such overdensities. These QSOs redshifts were determined only via broad, high-ionization emission lines in the rest-frame UV, often strongly shifted with respect to the systemic redshifts. Alternatively, radio-loud sources have been commonly found in rich environments, pinpointing the first protoclusters in the universe.
Here, we propose HST imaging observations to search for LAEs in the field of PSO172+18, the most distant radio source and the radio loudest QSO at z>6, using a suite of narrow and broad band filters with WFC3 and ACS/WFC. The systemic redshift of PSO172+18, z=6.823+-0.002, is accurately measured from observations of the narrow MgII emission line, and precisely locate the Lyman Alpha emission line in the response of the narrow band filter F953N, uniquely available on board HST.
Additionally, we will detect (or derive tight constraints on) the stellar emission of the QSO host galaxy, and search for any potential close (-kpc scale) companion.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Galaxies |
| ID: | 16144 |
| Program Title: | A Census of Metals in Low-Mass Galaxies: Quantifying the Metal Retention as a Function of Mass |


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|---|---|---|
| Principal Investigator: | Kristen | McQuinn |
| PI Institution: | Rutgers the State University of New Jersey | |



The metallicities of galaxies scale with stellar mass. Theoretical notions have long held that, in addition to lower star formation rates and efficiencies, the low metallicities of dwarf galaxies reflect their increasing inability to retain metals. This is seen in cosmological simulations where feedback-driven galactic winds transport metals from galaxy disks to large distances, with a steep inverse dependence of the amount of metals lost with galaxy mass.

At long last, it is possible to test this framework of stellar feedback and metal loss by actually tracking the metals in real galaxies. We propose to measure the production, distribution, and retention of metals in the stars and in the ISM in a large sample of low-mass, nearby galaxies over the critical mass range where metal loss is predicted to change the most but has yet to be investigated (i.e., 10^6 ~ 10^9 Msun). We will use an innovative technique that couples star formation histories derived from resolved stars with stellar and ISM metallicity constraints. Our program will measure, for the first time in the low-mass galaxy regime, the mean metal retention fraction as a function of galaxy mass, the dispersion on the relationship, and the differences in retention between the stars and the ISM. This "accounting" of the metals will provide significant constraints for models that will be far more detailed than global scaling relations with interdependent variables. Such analysis is only possible on nearby galaxies and our archival program capitalizes on the rich datasets available from the HST, supplemented by additional data from the VLA and ground-based observatories.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Solar System Astronomy

ID: 16315

Program Title: Drivers of Activity for Interstellar object 2I/2019 Q4 (Borisov)

Principal Investigator: Karen Meech

PI Institution: University of Hawaii

We request 5 orbits to observe the interstellar object 2I/2019 Q4 (Borisov) during the post-perihelion portion of its orbit, once it comes out of the HST solar avoidance region in mid-January 2021. Photometry from HST and from the ground shows that the comet is still bright, consistent with continued CO-driven activity, and that it is likely still to be bright enough to observe when it emerges again from solar conjunction. The requested data will be combined with high quality ground-based data, and HST imaging data obtained from several programs to perform detailed thermal modeling of the comet's activity, search for structures in the coma, and to perform high precision astrometry on the outbound orbit to model the non-gravitational forces acting on the nucleus. This is a unique object, only the second of its class discovered. 2I is now past perihelion at a heliocentric distance of 2.7 au and is heading out of the solar system and will never return. There is intense scientific interest in this object because it is likely a remnant of the planet building process from an exoplanetary system that we have been given the opportunity to observe in close detail, thus it is important to finish the observations necessary to fully utilize the huge scientific investment already made on this object.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16169

Program Title: The biological potential of other worlds: comparing the phosphorus content of wet and dry exoplanetary crusts

Principal Investigator: Carl Melis

PI Institution: University of California - San Diego

Life on Earth as we know it requires water and reliable access to phosphorus to drive basic biological processes. Studies of polluted white dwarf stars are able to detect both water and phosphorus in the accreted material from their extant planetary systems. In this proposal we seek to carefully examine the phosphorus content of a set of polluted white dwarf stars that are accreting the crust and mantle regions (the surface) of massive, differentiated rocky bodies. COS FUV spectroscopic observations of three white dwarf stars -- one water-rich and two relatively water-poor -- along with available data for another water-rich white dwarf will allow us to robustly assess their phosphorus content and compare the biological potential of very wet and more Earth-like worlds.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16289

Program Title: Multiple stellar populations in Globular Clusters: exploring the low mass regime

Principal Investigator: Antonino Milone

PI Institution: Universita degli Studi di Padova

Two broad scenarios have been suggested for the long-held problem of the formation of multiple populations (MPs) in Globular Clusters (GCs). According to the first option, GCs have experienced multiple star-formation episodes and provided a major contribution to the mass of the Galactic halo. As the alternative, there was a single star-formation episode, but a fraction of stars has successively accreted material processed and ejected by massive stars of the same generation. The mass functions (MFs) and the chemical composition of very-low mass M-dwarfs are the missing observational constraints to disentangle between the two scenarios.
Historically, MPs in the GCs have been mostly investigated from UV and visual filters that are very sensitive to the bizarre chemical composition of the GC stars more massive than ~0.6 solar masses. Due to the observational limits of the UV detectors, the faintest region of the color-magnitude diagram (CMD) is nearly unexplored. In the era of JWST, blind to the UV, the recent discovery, based on NIR HST photometry, of multiple sequences of very-low mass stars has provided a new window to study MPs.
We propose to combine F110W and F160W photometry, which allows us to investigate the MPs phenomenon in the poorly-explored M-dwarf regime, with F275W, F336W, and F438W data, mandatory to explore the brightest region of the CMD. From the synergy of NIR, optical and UV photometry we will constrain the chemical composition of the MPs and derive for the first time their mass-functions in the interval between ~0.1 and 0.8 solar masses. Our results will provide a major step forward to constrain the formation scenarios of MPs

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Solar System Astronomy

ID: 16211

Program Title: A systematic study of auroral processes at Ganymede

Principal Investigator: Pippa Molyneux

PI Institution: Southwest Research Institute

Ganymede is the primary target of the upcoming JUICE mission, but many open questions currently exist about the unique magnetosphere-within-a-magnetosphere interaction between Ganymede and Jupiter. The ~10 degree offset between Jupiter's rotation and magnetic axes leads to a time-varying interaction between the magnetospheres of the two bodies, with Ganymede encountering the densest Jovian plasma at System III longitudes around 110 and 290 degrees. Previous observations of Ganymede's ultraviolet auroral emissions indicated that the orbital trailing and leading hemispheres respond differently to the changing plasma environment; the leading hemisphere emissions were found to be significantly more variable than the trailing emissions on a range of timescales. However, the two hemispheres were observed in different regions of System III longitude, and it is unclear if the difference in variability was real, or related to changes in the rate of reconnection with System III, as suggested by a recent analysis of radio observations. Our proposed program addresses this question by observing both hemispheres over a wide range of System III longitudes, including both plasma sheet crossings and regions of high and low radio emission probability, thereby conclusively determining whether the apparent disparate behavior of the two hemispheres is real. Our proposed observations, using COS G130M, will also provide the ability to test previous analysis of the expected O/O2 ratio in Ganymede's atmosphere, and will place constraints on S ions local to Ganymede. An improved understanding of the near-Ganymede environment will provide useful information in advance of the JUICE mission.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16259

Program Title: 3D-DASH: A Wide Field WFC3/IR Survey of COSMOS

Principal Investigator: Ivelina Momcheva

PI Institution: Space Telescope Science Institute

The Hubble Space Telescope has enabled us to establish a broad picture of how present day galaxies came to be. We propose to extend this legacy into unprecedented new territory - degree-scale infrared imaging and spectroscopy - that will allow us for the first time to study the physical processes that shape the behemoths of the universe: the most massive, highly-star-forming, rare galaxies up to z=3.5. Using the "drift and shift" (DASH) technique, developed in Cycle 23, we propose to survey the entire 1.7 sq. deg. COSMOS field in WFC3/H(F160W) and WFC3/G141 in order to map the build up of stellar structure via >1000 resolved H-alpha maps, carry out a statistically robust census of ~450 M>10^11 M_sun galaxies, identify up to 100 massive major mergers to constrain theoretical models, determine emission line redshifts for ~37,000 z>0.7 galaxies and provide the most accurate predictions on the bias and number density of emission line galaxies prior to Euclid and WFIRST. 3D-DASH will create a wide shallow tier in the infrared "wedding cake" of extragalactic surveys, increasing the area observed with infrared grism spectroscopy by almost an order of magnitude and adding HST-resolution infrared imaging to COSMOS, one of the most actively studied fields. This program will fill in an important gap in HST extragalactic surveys in the pre-JWST era and is unlikely to be surpassed in sensitivity, area and resolution until the launch of WFIRST.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Galaxies

ID: 16145

Program Title: The Dust Extinction Law in Local Galaxies: Enhancing HST Data Products from Cosmological Galaxy Formation Simulations

Principal Investigator: Desika Narayanan

PI Institution: University of Florida

The extinction of UV-NIR photons from starlight by cosmic dust represents a significant uncertainty in the derivation of galaxy physical properties. While HST has played a foundational role in deriving dust extinction laws in the Galaxy and nearby systems, these observations have demonstrated that there is significant dispersion in the reddening law both from sightline to sightline in the Milky Way, as well as from galaxy to galaxy in the Local Group. No universal dust extinction law exists. The fundamental goal of this Theory/AR proposal is to deploy new hydrodynamic galaxy formation simulations that model the formation, growth, and destruction of dust over cosmic time to provide the first cosmologically motivated model for dust extinction laws in galaxies. This on-the-fly model includes the detailed physics of dust formation in stellar ejecta, growth in the ISM, and destruction processes. Our goal with these models is to use the simulation data products to: [1] develop an understanding for the origin of and expected dispersion amongst extinction laws in Local Group-like galaxies; and [2] develop a modern parameterization of the dust extinction law in order to facilitate the interpretation of UV-NIR HST observations toward star clusters and galaxies.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Galaxies

ID: 16146

Program Title: Pirate: Walking the Plank to Spatially Resolved Stellar Populations in CANDELS

Principal Investigator: Erica Nelson

PI Institution: University of Colorado at Boulder

HST has invested thousands of orbits imaging extragalactic deep fields with the goal of understanding the structural evolution of galaxies. Determining how galaxies grow requires transforming the distribution of light we observe into maps of stellar mass and star formation through cosmic time. This is challenging because a significant fraction of the light from young stars is absorbed and radiated further into the infrared, beyond Hubble's wavelength coverage. Deriving reliable estimates of physical quantities requires a modeling framework that can synthesize resolved and unresolved data. Here we propose the development of a next generation tool: Pirate. Pirate is built within Prospector, a Bayesian inference framework designed to constrain high-dimensional, self-consistent models of galaxies using broad-band photometry. Pirate extends Prospector to a resolved framework with an innovative hierarchical model to optimally constrain spatially resolved physical properties of galaxies from data with heterogeneous resolutions. With the ability to map stellar mass and star formation in galaxies at $0.5<z<2.5$ with reliable uncertainties, we will place new constraints on how galaxies grow at their peak formation epoch: where stars form, where galaxies quench, and how galaxies grow in size and build their build their bulges. A wealth of science will be enabled through a public release of all maps of stellar population properties, as well as, most importantly, the Pirate software package itself. Pirate is a forward looking tool that requires development and optimization leading up to the next era of higher spatial resolution data coming with ALMA, JWST, and the 30-meter telescopes.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Solar System Astronomy |
| ID: | 16195 |
| Program Title: | A Tail of Two Giants: Observing Saturn's FUV auroras in Jupiter's magnetotail in 2020 |


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| Principal Investigator: | Jonathan | Nichols |
| PI Institution: | University of Leicester | |



In November 2020, Saturn will pass through Jupiter's vast magnetotail. No other planet experiences such an event, which occurs for Saturn once every 19 years. It presents a unique natural experiment to capture the behaviour of a planet's magnetosphere in the absence of driving by the solar wind. A major scientific question for outer planetary magnetospheres is to understand the relative importance of internally- and externally-driven processes. Because of the rarity of this occurrence, however, planetary auroras have never been observed when the solar wind driver is all but removed. These proposed observations during Saturn's encounter with Jupiter's magnetotail present a crucial and unique opportunity to answer the following science questions:

* Does encountering Jupiter's magnetotail affect Saturn's auroras?
* What is the effect on a magnetosphere when solar wind driving is eliminated?
* Is Saturn's magnetosphere dominated by solar wind or internal processes?
* Is the solar wind interaction required for the existence of Saturn's main auroral oval?
* How does a dramatic expansion of the magnetosphere affect the flow and loss from the magnetosphere of plasma originating from Enceladus?
* Is the enigmatic magnetospheric planetary period oscillation modified by the encounter?
* Is dayside magnetic reconnection affected by the magnetotail encounter?

The HST is the only observatory capable of obtaining these FUV observations, and this encounter will not occur again during the lifetime of HST. We thus propose to image Saturn's northern auroras with HST/STIS during October-November 2020 to discover the planet's auroral morphology and evolution during this exciting

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Galaxies |
| ID: | 16300 |
| Program Title: | Toward a Spatially-resolved Kennicutt-Schmidt Law in High-redshift Cluster Galaxies: the Interplay Between Molecular Gas, Star Formation, and Stellar Mass with ALMA and HST |
| Principal Investigator: | Allison Noble |
| PI Institution: | Arizona State University |

Our understanding of how gas is converted into stars on small spatial scales within z > 0.1 main-sequence galaxies has been hindered by a dearth of high-resolution imaging of the molecular gas component. However, a new window into spatially-resolved molecular gas has recently opened through ALMA observations of high-redshift galaxy clusters. These gains have been largely due to the high source density of star forming galaxies in young clusters, which allows for efficient multiplexing. The ALMA observations have yielded exquisite velocity maps and morphological analyses for the first large sample of spatially-resolved molecular gas in high-redshift galaxies. By combining these novel ALMA data with rest-frame UV imaging using ACS/WFC F475W and F625W, we will investigate the interplay between gas, star formation, and stellar mass on kiloparsec scales, for ~30 main-sequence cluster galaxies at z~1.6. This will be the first determination of the spatially-resolved Kennicutt-Schmidt law for a large sample of galaxies at high redshift, and will be a pioneering study of how gas is consumed by star formation on sub-galactic scales near the peak of cosmic star formation.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Intergalactic Medium and the Circumgalactic

ID: 16245

Program Title: Mapping Lyman alpha and ionization in the leakiest galaxies

Principal Investigator: Goeran Oestlin

PI Institution: Stockholm University

Understanding cosmic reionization, and how galaxies contributed to it, is a very active field in extragalactic research. Since directly detecting the ionizing Lyman continuum (LyC) from galaxies in the epoch of reionization (EoR) is impossible, much attention has been given to the study of the conditions for LyC escape in low redshift (z) analogs with properties akin to those expected for galaxies in the EoR. Recently many LyC leaking galaxies have been identified in the low-z universe with HST/COS, and the strategy of selecting emission line galaxies with high ionization, as revealed by their [OIII]/[OII] ratios, has been particularly successful. The Lyman alpha (Lya) emission line from hydrogen is another vital probe of the high-z universe and is extensively used to find galaxies and determine their redshifts. Being a resonant line, the observability of Lya is very sensitive to the amount of neutral hydrogen in the interstellar medium (ISM) and it has been found that Lya emission is often dominated by large halos, likely formed by resonant scattering.

Here we propose an imaging study of the Lya and ionized gas emission in three low-z galaxies with the highest (38-72%) known LyC escape fractions. We will investigate the existence of Lya halos, and map the ionization structure of the ISM, to investigate conditions for LyC escape and how isotropic it is.

In addition, for the source with highest escape fraction, its slightly higher redshift makes direct imaging of the LyC feasible. This rare opportunity means that the spatial distribution of the ionizing radiation and its escape fraction can be mapped and related to the local ionization level and dust content.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Intergalactic Medium and the Circumgalactic

ID: 16260

Program Title: Tied up in Knots: The Spatially Resolved LyC Escape from Haro 11

Principal Investigator: Sally Oey

PI Institution: University of Michigan

The nearest and most well-studied Lyman continuum (LyC) emitting galaxy, Haro 11, offers an unparalleled opportunity to determine the conditions for LyC escape at 15-pc resolution. However, we do not know which of the 3 dominant star-forming knots is the LyC source: Knot C is a strong Ly-alpha emitter (LAE) with an ultraluminous X-ray source (ULX); Knot B hosts a very luminous ULX that is a candidate low-luminosity AGN (LLAGN); and Knot A is a starburst driving optically thin, Green Pea-like properties. Our proposed COS spectra of the LyC will identify which of the three knots is responsible for the known LyC emission. Depending on which Knot is confirmed as the LyC emitter (LCE), it would illuminate the connection between LyC escape and: LAEs and ULXs (Knot C); ULXs/LLAGN (Knot B); or Green Peas (Knot A). If Knot C is not confirmed, then this would overturn the widely held paradigm that all LCEs must be strong LAEs. If Knot B or C is the LyC source, then this first confirmation of a ULX LCE would imply that black hole accretion processes in dwarf galaxies may be a viable cosmological source of LyC. By establishing the LyC source in this iconic galaxy, these observations will allow much-needed, spatially resolved, detailed study of the radiative transfer of LyC from the ionizing source through the local ISM. Our results will clarify understanding of LyC escape and its relation to Ly-alpha, and inform efforts to identify LCEs at higher redshift.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16261

Program Title: Mrk 71: Prototype for Catastrophic Cooling in a Green Pea Analog

Principal Investigator: Sally Oey

PI Institution: University of Michigan

The new paradigm for extreme feedback from metal-poor, compact, super star clusters (SSCs) has superwinds suppressed due to catastrophic radiative cooling of weak winds in high-density conditions. This cooling generates strong nebular line radiation in C IV, whose spatial morphology contrasts with that of He II. We propose the first ever, nebular C IV imaging with ACS/SBC to test for these conditions in Mrk 71, a metal-poor (0.1 Z_sun), nearby starburst complex with strong evidence of suppressed superwinds. This system is a uniquely accessible, spatially resolved analog of the Lyman continuum-emitting Green Pea galaxies, a population of cosmological importance, in which suppressed superwinds appear to be relevant. We also propose STIS FUV + optical observations to identify the stellar population of the parent super star cluster Mrk 71-A, which may host very massive stars > 100 M_sun. The STIS long slit will also include a second massive cluster, Mrk 71-B, that is driving a conventional, adiabatic superbubble system; this will allow us to also calibrate classical, adiabatic feedback in this cosmologically important, low-metallicity regime.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16182

Program Title: Catching wind with the HST: novel UV spectroscopy of a bona fide ultraluminous X-ray source

Principal Investigator: Lida Oskinova

PI Institution: Universitat Potsdam

We request 17 orbits to secure for the first time an UV spectrum of a generic ultraluminous X-ray source (ULX). Consisting of an accreting compact object, a neutron star or a black hole, and a non-degenerate donor star, ULXs have highest X-ray luminosities among all types of X-ray binaries. These ultra-high luminosities can be achieved either (1) because of an unusual supercritical regime of accretion, or/and (2) because the black holes have masses exceeding a few tens solar, i.e., in the upper range among those detected by gravitational wave observatories. Advances in X-ray astronomy have already proven that supercritically accreting systems indeed exist among the ULX population. Herewith, we request UV spectroscopy to probe the second scenario and establish the existence of ULXs consisting of heavy black holes in a close orbit around a very massive star.

ULXs have a broad spectral energy distribution, from X-rays to UV to optical. They are well studied in X-rays, while optical spectra are secured for about ten ULXs. However, no UV spectrum of an ULX exists yet. We propose to close this gap by obtaining a high-quality UV spectrum of the bona fide ULX, Ho II X-1. Our target is the closest among the generic group of those ULXs which show Wolf-Rayet spectra in the optical. The COS spectra will test whether we observe the donor star or the accretion disk wind. Securing the first UV spectrum of a typical ULX is also necessary to gauge the models of the Universe re-ionization which incorporate ULXs as important feedback agents. The UV spectroscopy of an ULX is a necessary addition to the HST UV legacy.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16224

Program Title: Pathways to compact white dwarf binaries

Principal Investigator: Steven Parsons

PI Institution: University of Sheffield

Close binaries containing at least one white dwarf (WD) are thought to be the progenitors of some of the Galaxy's most exotic objects, such as cataclysmic variables, AM CVn binaries, hot subdwarf stars, double degenerates and thermonuclear supernovae (SN), including the cosmologically important SN Ia. This zoo of possible evolutionary outcomes demonstrates the complexity of trying to study the population of WD binaries as a whole. However, without a detailed understanding of the evolution of WD binaries, we will remain unable to unravel the pathways towards thermonuclear SN and the conditions under which they ignite, and equally, we will not be able to accurately predict or model the low-frequency gravitational background from galactic WD binaries. Here we propose to take a step back in time to the last stage at which all of these systems were part of the same population of detached WD plus main-sequence star binaries. The properties of these binaries can reveal their past evolution and measure how common different evolutionary channels are. However, at optical wavelengths the WD components are overwhelmed by their main-sequence companions making it difficult to determine their masses. Using TESS data we are able to circumvent this by measuring the rotation rate of the stars and comparing this to rotational broadening measurements, to measure the binary inclinations and thus WD masses for dozens of systems. However, this method relies on the alignment of the spin and orbit of the stars which is by no means proven. Here we request HST/STIS data to confirm if our method yields the correct WD masses for these powerful probes of WD binary evolution.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16212

Program Title: HST Spectroscopy of a Fast-Rising Luminous Ultraviolet Transient

Principal Investigator: Daniel Perley

PI Institution: Liverpool John Moores University

The extremely luminous, fast, hot transient AT2018cow has provoked a reconsideration in our view of the transient sky. This event, by far the nearest example of the class of fast-rising luminous transients (sometimes referred to as FBOTs or FELTs), displayed an array of peculiar properties that highly strain theoretical models for what is possible in a supernova explosion. For all their peculiarities, however, fast-rising transients are not rare in a volumetric sense - and with ZTF and ATLAS both obtaining high-cadence observations of wide areas of the northern sky it is probable that another such event will be observed in the coming year. These are primarily ultraviolet phenomena, and UV spectroscopy has the power to reveal similarities or differences betwen this event and other known varieties of transient (including young CCSNe, superluminous SNe, and TDEs) that are not apparent in optical observations alone, and to discover (or rule out) the presence of a dense stellar wind around the progenitor. We propose to obtain target-of-opportunity UV spectroscopy of another event of this type in Cycle 28 to critically evaluate these links and secure the physical origins of this class while HST's unique UV spectroscopic resource is still available.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16196

Program Title: Mapping Gas Flows in AGNs by Reverberation

Principal Investigator: Bradley Peterson

PI Institution: The Ohio State University

We propose to determine the location and kinematics of the high-ionization gas in the active galactic nucleus of Mrk 817 via broad emission-line reverberation mapping. Understanding the geometry and kinematics of the broad emission-line region is crucial (a) for identifying where disk winds are launched, (b) for identifying the driving mechanism, and (c) for understanding the radiative and kinetic outflows from nuclei that will allow us to assess the possible impact of AGN feedback on the host galaxy. Moreover, since the masses of the highest-redshift quasars are estimated based on scaling relationships involving the C IV 1549 emission line, the kinematics of the C IV line-emitting region must be known to assess the accuracy of such determinations. We propose to obtain 180 COS spectra of Mrk 817, one orbit approximately every other day for a year. This program is modeled after a similar highly successful and high impact monitoring program on NGC 5548 with COS in Cycle 21. The primary science goal is to determine the geometry and kinematics of the C IV and Ly alpha emitting regions. Mrk 817 is a higher luminosity and higher Eddington ratio source than NGC 5548 and therefore likely to have a strong disk wind, although our line of sight to the nucleus is unabsorbed. The NGC 5548 program showed that X-ray data are of critical importance in understanding the ionizing spectrum so accompanying low-cadence Chandra monitoring is also requested. A secondary science goal is continuum reverberation, and our request includes five additional observations with STIS to resolve current ambiguities about the contribution of diffuse broad-line region emission to the continuum.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16197

Program Title: Chromosopheric and Coronal Activity in the Lowest-Mass Stars

Principal Investigator: John Pineda

PI Institution: University of Colorado at Boulder

The recent discovery of the seven planet TRAPPIST--1 system, including three habitable zone planets, has opened up a new avenue for studying temperate terrrestrial planets, with potentially habitable atmospheres. This system and others like it around the lowest-mass stars will be prime targets for both planet searches and studies to directly characterize the atmospheres of Earth-sized exoplanets. Understanding these atmospheric observations and the potential prospect of such exoplanets to develop and sustain life critically depends on the high-energy stellar radiation environment from X-ray to ultraviolent wavelengths because of the ability of this emission to drive atmospheric mass-loss, and it's strong influence on planetary photochemistry, including its ability to catalyze prebiotic chemical pathways. However, little is known about the X-ray to UV radiation field of stars at the end of the main sequence. We propose a survey of the joint X-ray and UV emission of a sample of M7-M9 dwarfs, to provide the basis for estimating the high-energy stellar radiation environment around these stars across a range of activity levels, and to use these spectral observations as inputs to planetary photochemsitry models. Furthermore, these observations will probe the nature of chromospheric and coronal heating in the coolest stellar atmospheres.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Solar System Astronomy

ID: 16183

Program Title: Followup High-Precision Astrometry and Binary Searches of Potential New Horizons KBO Targets

Principal Investigator: Simon Porter

PI Institution: Southwest Research Institute

We propose to use WFC3 to observe approximately 36 Kuiper Belt Objects (KBOs) with up to 58 orbits of HST, in order to 1) Enable unique and unreproducable high-phase observations of them with New Horizons, 2) Significantly expand the number of dynamically-excited KBOs that have been checked to see if they are binary, and 3) Enable future ground-based occultation studies to measure the sizes and shapes of KBOs. Our first science goal requires New Horizons, but coordinated observations with NH and HST would produce a unique dataset that no other combination of facilities can match. Our second and third science goals do not require New Horizons, and build upon current and past HST KBO programs. All of our science goals independently would provide a significant advance in the field of KBO science, and together constitute a clear advance in understanding both KBOs specifically, and planetesimal formation across the Solar System in general. We expect that our proposed observations will increase the number of objects that New Horizons can observe in late 2020-early 2021 from ~6 to ~42. This will provide a seven-fold increase in the number of KBOs that New Horizons can measure high-phase lightcurves for, greatly enhancing our understanding of the shapes and surface regoliths of KBOs. The proposed observations would also serve as a survey of the binary fraction of dynamically excited KBOs, which is poorly-constrained currently, especially compared to the Cold Classical KBOs. Our proposed observations would also enhance the orbital precision of these objects sufficiently to enable ground-based stellar occultation campaigns of them, uniquely capable of measuring shape and size.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Intergalactic Medium and the Circumgalactic

ID: 16301

Program Title: The Circumgalactic Medium at the Lowest Mass End

Principal Investigator: Mary Putman

PI Institution: Columbia University in the City of New York

COS has created a legacy with the detection of large quantities of baryons in dark matter halos; however, there remains a crucial unprobed mass scale. Dwarf galaxies, or dark matter halo masses < 10^10.5 Msun, appear to have lost the vast majority of their baryons, but beyond the central few kpc the baryon distribution is unknown. The circumgalactic medium (CGM) may now harbor the baryons. CGM observations of dwarf galaxies provide crucial insight into the missing baryon problem and feedback efficiency at the low mass end.

We propose to study the distribution, kinematics, metal content, and ionization properties of the CGM of some of the smallest galaxies in the universe through UV-bright background QSOs within the virial radius of dwarf galaxies in the Local Volume. This sample is unique as the low mass range of the dwarf galaxies is unexplored and their proximity means comparisons can be made to their resolved stellar populations and gas distributions. The dwarf galaxy observations will allow for: (1) the ionization, mass and distribution of their CGM to be compared to larger galaxies, (2) constraints on the feedback prescriptions of state-of-the-art dwarf galaxy simulations, (3) a comparison of the metals in the CGM to what remains in the stars and gas in the main body of the dwarf galaxies.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16213

Program Title: Extreme Star-Forming Galaxies: Local laboratories to constrain models of ionizing sources in the reionization epoch

Principal Investigator: Swara Ravindranath

PI Institution: Space Telescope Science Institute

The rest-UV spectra of star-forming galaxies (SFGs) at z>6 serves as a primary tool to reveal the nature of ionizing sources that are responsible for the cosmic reionization. Low-metallicity star-forming dwarf galaxies at z<0.3, show similar strong UV emission lines (eg; CIV, He II, OIII], and CIII]), and are being used to calibrate the UV diagnostics that can be applied to study galaxies in the reionization epoch. However, the high equivalent widths (EW > 20 Angstrom) seen for UV emission lines in z>6 galaxies, have not been observed in any of the local analogs. Such high EWs pose a challenge to the photoionization models, requiring the lowest metallicities, youngest stellar ages, and highest ionization parameters as model inputs, to produce the required hard ionizing spectrum, and extreme emission lines. We propose to obtain HST COS (G140L) and STIS (G230L) spectra of a unique sample of 5 SFGs, recently identified as having extreme [OIII]/[OII] ratios (>22), high ionizing flux, and with evidence for hard ionizing radiation from young, massive stars with ages < 3 Myrs. The photoionization models predict high nebular CIV and CIII] EWs (> 15 Angstrom), comparable to galaxies in the reionization epoch. Our goal is to (1) compare the fluxes and EWs of the UV emission lines to model predictions, (2) calibrate the UV diagnostics that predict potential Lyman continuum escape, and (3) obtain constraints on the ionizing sources (very massive stars, WR stars, or binaries) based on the hardness of the ionizing radiation. The results from our analysis will offer crucial insights into stellar populations and conditions responsible for reionization.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | SNAP |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16225 |
| Program Title: | A SNAP Survey of the Local Interstellar Medium: New NUV Observations of Stars with Archived FUV Observations |


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| Principal Investigator: | Seth | Redfield |
| PI Institution: | Wesleyan University | |



We propose to obtain high-resolution STIS E230H SNAP observations of MgII and FeII interstellar absorption lines toward stars within 100 parsecs that already have moderate or high-resolution far-UV (FUV), 900-1700 A, observations available in the MAST Archive. Fundamental properties, such as temperature, turbulence, ionization, abundances, and depletions of gas in the local interstellar medium (LISM) can be measured by coupling such observations. Due to the wide spectral range of STIS, observations to study nearby stars also contain important data about the LISM embedded within their spectra. However, unlocking this information from the intrinsically broad and often saturated FUV absorption lines of low-mass ions, (DI, CII, NI, OI), requires first understanding the kinematic structure of the gas along the line of sight. This can be achieved with high resolution spectra of high-mass ions, (FeII, MgII), which have narrow absorption lines, and can resolve each individual velocity component (interstellar cloud). Obtaining short (~10 minute) E230H observations of FeII and MgII, for stars that already have moderate or high-resolution FUV spectra, will increase the sample of LISM specta, and enable new measurements of the physical properties of the gas in our galactic neighborhood. STIS is the only instrument capable of obtaining the required high resolution UV spectra now or in the foreseeable future.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16246

Program Title: Are Narrow Line Region Outflows an Effective Mode of AGN Feedback?

Principal Investigator: Mitchell Revalski

PI Institution: Space Telescope Science Institute

The ionizing radiation generated by accreting supermassive black holes can drive powerful outflows that may play a key role in galaxy evolution by evacuating the galactic bulge of gas. These outflows are observed in the narrow line regions (NLRs) of AGN and can only be accurately characterized using the high spatial-resolution imaging and spectroscopy afforded by HST. We will build a sample of 22 nearby AGN to determine the spatially-resolved extents, mass outflow rates, and kinetic luminosities of their NLR outflows. We will do this efficiently by obtaining new [O III] plus continuum images of 13 Seyfert galaxies and combining them with MAST archival long-slit STIS spectra and photoionization models to increase the current sample of 3 AGN by a factor of ~7. The mass outflow rates will provide direct measures of the removal of potential star-forming gas and the kinetic luminosities will identify the locations and amounts of energy deposited into the gas to disrupt star formation. We will then model the enclosed mass profiles of the host galaxies to find their bulge radii and determine the extent to which radiation can drive outflows in the gravitational potential of the galaxy. The sample spans a significant range in luminosity, black hole mass, and Eddington ratio, allowing us to map the dependence of these outflow parameters on AGN properties and thereby determine the effectiveness of NLR outflows as a feedback mechanism in nearby AGN. This study will provide a baseline for interpreting outflows in AGN at higher redshifts, particularly with JWST, and increase the legacy value of the archival STIS spectra by providing matching [O III] images for future NLR studies.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Large Scale Structure of the Universe |
| ID: | 16198 |
| Program Title: | From Masers to Coma, A Single Step Measurement of the Hubble Constant and a Reservoir of New SNe Ia |


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



We propose to scrutinize the puzzling tension in measurements of the Hubble constant by constructing a two-rung ladder, using only Cepheids, that extends to the Coma Cluster (~100 Mpc), and improving the ladder's calibration by tripling the sample of long-period (P>33 day) Cepheids in the megamaser host, NGC 4258. Unlike previous Cepheid- and TRGB-based ladders, the proposed method is independent of Type Ia SNe, and thus is free of any biases that might accrue from changes in their properties between the local Universe and in the Hubble flow. Two ambitious programs with ACS and WFC3 used over 100 orbits to discover 28 long-period Cepheids in the Coma cluster that define a convincing optical-only, period-luminosity relation. However, pervasive dust lanes are also readily apparent near these Cepheids making the reddening uncertainty the largest remaining contributor to this Cepheid distance in the Hubble flow. We propose to follow-up these Cepheids with deep WFC3-NIR imaging to overcome contamination by dust and to measure these Cepheids consistently with all other Cepheid-SN Ia hosts. We propose to improve the calibration of these Cepheids in Coma (and in other hosts) by capitalizing on the improved geometric maser distance to NGC 4258 with multi-epoch, coordinated parallel imaging to find triple the number of known long-period Cepheids in the maser host. By building on past efforts to reach Coma we will also economically tap a new reservoir of SNe, a two-for-one approach to continue improving the precision of the leading method to measure the Hubble constant to help find the underlying source of the tension.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16217

Program Title: Identifying Double White Dwarf Binaries in Globular Clusters

Principal Investigator: Liliana Rivera Sandoval

PI Institution: Texas Tech University

Double white dwarf binaries (aka AM CVns) are systems with orbital periods ~5-65 mins. Because of their short orbits, they are important sources of low-frequency gravitational waves. They are also candidates for progenitors of SN Ia through the double degenerate path. In globular clusters (GCs) they are predicted to exist in large amounts due to stellar interactions. However, no single AM CVn has yet been confirmed in any GC. We propose to carry out the first multi-epoch UV study of the low extinction, relatively massive Galactic GC 47 Tuc to identify the missing population of AM CVns through their outbursts. Using this novel technique we will test dynamical formation and evolutionary models of these binaries in clusters. We will also refine predictions of AM CVns as potential gravitational wave sources to be detected with LISA. Finding an upper limit on the rate of identifications that is lower than expected would change the current paradigm of GCs as efficient factories of compact binaries, especially those harboring white dwarfs. That would mean that the double degenerate path for SN Ia is negligible, which ultimately has cosmological implications.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16218

Program Title: Confirming the first double degenerates in globular clusters

Principal Investigator: Liliana Rivera Sandoval

PI Institution: Texas Tech University

The first 3 good candidates to AM CVn (double degenerate binaries) binaries in a globular cluster were recently identified with HST photometry. One of them is N1851-FUV1 which was identified as a short period (18 minutes) far-ultraviolet variable near the center of the globular cluster NGC 1851 (Zurek et al 2016). The other 2 candidates have been identified in the globular cluster 47 Tuc (Rivera Sandoval et al 2018) based on a combination of the their X-ray and optical/near-ultraviolet properties. A far-ultraviolet spectrum of each of these candidates will confirm or refute these candidates as AM CVn. Their confirmation will establish globular clusters as factories of compact binaries that emit gravitational waves and which are expected to be detected with LISA. The characterization of these systems is crucial to be performed while HST is still working, as it is the only telescope capable to resolve the stars in the cores of globular clusters. If confirmed, the first comparison to AM CVns in the Galactic field will be possible, giving direct evidence of the impact of stellar interactions in their formation and evolution. This program may enable follow-up studies to set important constraints on double degenerate binary models.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16321

Program Title: A search for variable stars and compact binaries in globular clusters with HST

Principal Investigator: Liliana Rivera Sandoval

PI Institution: Texas Tech University

Globular clusters (GCs) are very old, gravitationally bound groups of stars. Due to their age and high stellar interactions, they are home of a significant fraction of exotic binaries. These binary systems not only govern the evolution of their host GCs, but studying them is likewise important for understanding the importance of clusters as factories of compact mergers like Type Ia supernovae, kilonovae and black hole mergers, and for LISA-band gravitational wave sources. One of the most common compact binaries expected to reside in GCs are the cataclysmic variables (CVs). Their number, spatial and period distribution can give us a clue on the past GCs, helping us constrain models of stellar and dynamical evolution. However, the current known CV population is well below the expected numbers. Observational biases might be playing a key role. In particular, a X-ray unbiased search has not been performed for many Galactic GCs. We propose to carry out a homogenous analysis of archival data for 7 GCs with different dynamical states and properties in order to test CV evolution. The search will be performed in different parts of the GCs. We will then be able to make the first direct comparison between the CV populations in GCs and the Galactic disk, obtaining direct insights of the effects of stellar interactions on the formation of these binaries. We will also search for orbital periods in an attempt to populate the period distribution of CVs in GCs for the first time. Furthermore, we will look for HST counterparts to the known X-ray and radio sources in our GCs sample, having the possibility of detecting binaries which harbor black holes and neutron stars.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Large Scale Structure of the Universe

ID: 16264

Program Title: LensWatch: Time Delay Measurement of a Multiply-Imaged Supernova

Principal Investigator: Steve Rodney

PI Institution: University of South Carolina

By measuring the time delay between any pair of gravitationally lensed images, we can constrain the expansion rate of the universe and test dark energy models. Variable quasars have been used in this way with great success, and it is now possible to extend this technique to gravitationally lensed supernovae (SNe). These targets are especially promising because their predictable light curves can deliver precise time delay measurements in a relatively short period. Existing surveys have a realistic chance of discovering at least one new lensed SN within the next 1-3 years. This long-term target of opportunity program will provide the high-resolution follow-up imaging that is critical for measuring a lensed SN time delay. This program will enable a time delay measurement with uncertainty of approximately +-3 days, leading to a new measurement of H0 with a precision of 5-10% for a flat LambdaCDM cosmology---comparable to the best constraints achieved with lensed quasars. Future wide-field surveys (e.g., LSST, WFIRST) could deliver hundreds of lensed SN time delays, but the sample size will be limited by follow-up resources. This pilot study is an important step to establish lensed SNe as a competitive cosmological tool in the coming wide-field survey era.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Solar System Astronomy

ID: 16199

Program Title: Exploiting the fortunate Jupiter transit geometry to probe Ganymede's and Callisto's atmospheres

Principal Investigator: Lorenz Roth

PI Institution: Royal Institute of Technology

Ganymede and Callisto are primary targets of ESA's JUpiter Icy Moon Explorer (JUICE) and NASA's Europa Clipper mission: Callisto will be visited with a total of about 20 flybys. Ganymede will be the first planetary moon to be orbited by a spacecraft (JUICE). Today, the atmospheres of the two icy moons are only loosely constrained by observations. Oxygen, the domimant atmospheric species, is observable only through faint electron-excited emissions, complicating derivation of reliable neutral gas abundances or distribution due to poorly constrained electron properties.

STIS spectral imaging has recently proven to be a sensitive tool for investigating Io and Europa while in transit of Jupiter: Atmospheres and plume abundances are probed through extinction of the bright Jupiter Ly-alpha background - independently of electron properties. The observing geometry now during HST Cycle 28 provides optimal conditions to also observe Ganymede and Callisto in transit of Jupiter. Both moons have long (>3.5 h) transits near the Ly-alpha-bright equator of the planet, a condition that is fulfilled only every ~6 years. We propose to observe Ganymede and Callisto during one transit of Jupiter each with two consecutive HST orbits. The observations will provide the most precise measurements of the H atmospheres and the first ever spatially resolved constraints on atmospheric H2O - from sublimation or outgassing - for the two largest moons of Jupiter. The transit geometry provides the unique opportunity to measure hemispheric differences in the atmospheres, which likely arise from the moons' surface volatile distributions as known via albedo dichotomies between the trailing and leading sides.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Intergalactic Medium and the Circumgalactic |
| ID: | 16231 |
| Program Title: | Witnessing the circumgalactic medium in formation: Imaging OVI in the warm-hot CGM of a record-breaking galactic wind |


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| Principal Investigator: | David | Rupke |
| PI Institution: | Rhodes College | |



The massive, compact galaxy Makani hosts one of the largest [OII] nebulae, and perhaps the largest starburst-driven galactic wind, yet detected. This wind extends well into the CGM of its host (r_wind > 20r_stars) and is a snapshot of the CGM-in-formation. The cool, dense medium of the wind-CGM interface in Makani (traced in emission by [OII], MgII, and CO emission) on scales of 100 kpc show an outflow forming the cool CGM in real time. Much of our knowledge of the CGM in other galaxies is derived from statistical studies of the warm-hot (10^5-10^6 K) phase. The enormous and lumionus oxygen nebula in Makani is the ideal target to *image* the warm-hot CGM, which is difficult in most other sources. We propose to make the first "rebirth picture" of the warm-hot CGM as it is being formed anew by the giant wind in Makani. We will image Makani in OVI 1032, 1038 A with ACS/SBC, a technique that recently yielded the first OVI image of the halo of a starburst galaxy (Hayes et al. 2016). We will apply the same synthetic narrowband technique which is perfectly suited for Makani, whose observed-frame OVI line (at z=0.459) lies at the peak of the F150LP filter. These observations are optimally-timed to meet simulated images of OVI that are emerging from the latest simulations. The morphology of the OVI image and line flux ratios with [OII] will constrain the physical state of the gas in the nebula through comparison with models and simulations of the wind-CGM interaction and shock +photoionization models.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Galaxies |
| ID: | 16147 |
| Program Title: | CENSUS-2175: Constraining Extinction with NUV Spectroscopy of UV-bright Star-forming galaxies-via the 2175-Angstrom bump |


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| Principal Investigator: | Michael | Rutkowski |
| PI Institution: | Minnesota State University, Mankato | |



Dust is pervasive in high redshift galaxies, and assumptions about how it attenuates starlight and impacts conditions in the ISM strongly affect conclusions on the intensity and history of star formation for these galaxies. At present, these model assumptions are underconstrained using data obtained with HST and Spitzer. We propose to test whether the key standard assumption made in modeling high redshift galaxy (z>6) rest-frame UV spectral energy distributions - that high-z galaxies lack a significant 2175 Angstrom Bump feature - is valid. We will use deep archival HST near IR grism spectroscopy to make the first direct spectroscopic census of the 2175 Angstrom bump in 2<z<4 galaxies. Our analysis will provide a novel assessment of the nature and evolution of dust in these galaxies, allowing us to better understand how star formation can modify dust in the ISM. Specifically we will:

1) Detect and measure the 2175A Bump profile for a large (~800) sample of 2<z<4 galaxies;

2) Determine the most appropriate dust attenutation models for these objects, incorporating, for the first time at this redshift, both rest-frame UV spectroscopy and optical broadband imaging;

3) Re-derive stellar population parameters (Age, Mass, Star formation intensity and history) corrected for attenuation, for individually detected 2175A host galaxies and for relevant subsets of galaxies; and

4) Re-assess popular proxies for LyC emissivity that rely on (under-constrained) measurements of UV continuum.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16316

Program Title: GULP: Galaxy UV Legacy Project

Principal Investigator: Elena Sabbi

PI Institution: Space Telescope Science Institute

Massive OB stars are rare and short lived. Yet they dominate the ultraviolet luminosities of star forming galaxies, produce alpha elements, and are mechanical energy powerhouses through their stellar winds and supernovae. OB stars are difficult to study and our knowledge of massive star populations is largely limited to the Milky Way and its nearby companions. We propose to use an efficient large-dither-mosaicking observing strategy to resolve and map OB star populations in 27 nearby galaxies within 7.5 Mpc by obtaining FUV and NUV images with the ACS/SBC and WFC3/UVIS on HST. GULP will observe galaxies covering a wide range of masses, metallicities, and star formation activity levels. GULP multi-wavelength data will capture large numbers of massive young stars in clusters, OB associations, and in field populations. GULP will provide a unique basis for calibrating modern massive star evolutionary models, investigating the upper IMF and its dependence on metallicity and environment, and understanding the role of stellar feedback in determining the evolution of starbursts and star-forming galaxies. GULP will allow us to link the properties of massive stars from their birth to their demise as supernovae. The project makes effective use of archival HST data, adding unique UV photometry, and allowing us to simultaneously investigate UV dust obscuration in a variety of galaxies. Results from GULP will thus provide a strong quantitative basis for quantifying the dust attenuation at FUV and NUV wavelengths, indispensable for interpreting the rest-frame UV spectra of youthful galaxies with JWST.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16232

Program Title: Investigating The Interstellar Bullet Engine IRAS05506+2414

Principal Investigator: Raghvendra Sahai

PI Institution: Jet Propulsion Laboratory

An exciting development in the understanding of the early evolutionary stages of massive stars, based on a new study of the Orion BN/KL region, is that the disruption of a massive young stellar system can lead to an explosive event producing a wide-angle outflow - an entirely different phenomenon from the classical bipolar flows driven by YSO accretion disks. We have discovered an object, IRAS05506+2414, which may be the 2nd clear-cut example of this phenomenon. Our HST optical and near-IR images show a fan-like spray of high-velocity (up to 350 km/s) elongated knots which appear to emanate from a bright compact central source; we find that the physical properties (opening angle, outflow speeds, knot masses, Herbig-Haro-object like optical line emission) of the IRAS05506 wide-angle outflow are very similar to those seen in Orion.

We propose to determine IRAS05506's distance from a measurement of the knot proper motions using WFC3 to obtain a 2nd epoch F606W image. Only then will we be able to robustly constrain the central star's luminosity and mass and the dynamical time-scale, mass, velocity, and kinetic energy distributions of its outflows -- needed to test possible mechanisms for the explosive disintegration model for such sources. Deep emission-line imaging with WFC3 will be used to probe the full size and structure of the bullet spray. We will use STIS to confirm the presence of a second outflow engine in IRAS05506: an intriguing linear feature that looks like a classical YSO collimated jet can be seen emanating from the central source, but only a long-slit spectrum of the line emission with sufficient angular resolution can confirm it to be a high-velocity jet.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16200

Program Title: Discovering Isolated Stellar-Mass Black Holes Using Astrometric Microlensing

Principal Investigator: Kailash Sahu

PI Institution: Space Telescope Science Institute

There should be ~100 million black holes (BHs) in our Galaxy, of which the majority should be single. Yet there has been no unambiguous detection of a solitary BH--not surprisingly, since they emit essentially no radiation. Astrometric microlensing--the relativistic deflection of light from a background star--is the only technique that can detect isolated BHs. HST has demonstrated its capability to measure such tiny deflections.

A multi-year HST program of precision astrometry of long-duration microlensing events in the Galactic bulge is underway, aimed at the first detection of isolated BHs. This program has achieved clear detections of deflections in two events, consistent with non-luminous massive lenses. However, the timing of the observations was sub-optimal due to some guide-star failures and the HST gyro failure in 2018. As a result, there remains a degeneracy between deflection, parallax, and proper motion; an unusually slow-moving low-mass lens remains a possibility. One more observation of these two targets will resolve this degeneracy. Observations of another event had to be abandoned when HST revealed a blended source. Because of the 2018 HST gyro failure, initiation of two new events had to be delayed until 2019. These events are still ongoing and need a total of five orbits for completion. One of the BH candidate sources is extremely red, which can be best explained by a shell around the putative BH. A 1-orbit STIS spectrum, and a final WFC3 image in Cycle 29, will test this hypothesis. Thus a total of 9 orbits (7 in Cycle 28 and 2 in Cycle 29) are needed to achieve the original objectives of the program, and to confirm the potentially exciting findings.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16170 |
| Program Title: | Wolf-Rayet stars in the outskirts of M33: unveiling helium-star evolution and feedback at subsolar metallicity |


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| Principal Investigator: | Andreas | Sander |
| PI Institution: | Armagh Observatory | |



Massive stars are important drivers of the evolution of galaxies. They shape the structures around them and enrich the interstellar medium with metals due to their strong stellar winds. They ionize their environment and transfer momentum from the UV-dominated radiation field to metals. As the progenitors of heavy black holes, evolved massive stars have become a keystone of modern astrophysics. The masses of their black hole remnants predominantly depend on the wind mass loss of envelope-stripped helium (He) stars. The mass loss of these He-burning stars and its metallicity-dependence mark a crucial, yet poorly constrained astrophysical quantity.

He stars with a sufficiently high mass loss appear as Wolf-Rayet (WR) stars, detectable even in unresolved stellar populations and distant galaxies due to their strong emission lines. While the general presence of WR stars is known to be correlated with metallicity, recent studies show that current assumptions in stellar evolution and population models are too simplistic. Thus, a proper empirical determination of WR mass loss as a function of mass and metallicity is necessary to understand the true nature and complex metallicity-dependent behaviour of He star mass loss. The diagnostics to determine the metallicity of He stars can only be obtained from UV spectroscopy. We therefore propose COS UV observations of six WR stars in the outskirts of M33, providing a unique opportunity to study very massive evolved He stars at subsolar metallicity. By anchoring mass loss of WR stars in this crucial environment, our observations will deliver one of the most important ingredients needed for realistic stellar evolution and feedback models.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16247

Program Title: The radial chromosomic map of Omega Centauri

Principal Investigator: Michele Scalco

PI Institution: Osservatorio Astronomico di Padova

A complete characterization of the spatial distributions of the different multiple stellar populations in Omega Centauri is of fundamental importance to study their formation and dynamical history. Recent studies have revealed a very complex picture of this cluster and found the presence of 15 different sub-populations groups. While previous studies have found a radial gradient in the number fraction of the two major groups of stellar populations, nothing is known about the radial variation of all the other groups of sub-populations. Studies of all the sub-populations are available in the core (from the literature) and in the outermost regions (from HST archival observations) of the cluster, while data in the intermediate regions are missing. These intermediate regions are those where the strongest radial gradient of the two major groups of stars has been found and they are thus essential to explore possible structural differences between all the different sub-groups.

Here we propose to collect the missing observations needed to separate and identify all the sub-groups multiple populations in these two fields. This will give us the opportunity to obtain the necessary radial coverage to trace for the first time the radial gradient of all the multiple populations along almost the entire cluster. Such a major improvement requires a relatively modest investment of only two additional HST orbits.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16271

Program Title: A new window on the UV SED of star-forming galaxies: direct measurements of ionizing spectra in the Lyman continuum

Principal Investigator: Daniel Schaerer

PI Institution: Observatoire de Geneve

The Lyman continuum (LyC = hydrogen-ionizing radiation at wavelengths < 912 Ang) of galaxies plays a fundamental role in determining the physical and observational properties of the ISM and IGM, including cosmic reionization. Yet it is basically inaccessible to direct observations, and one therefore heavily relies on theoretical, yet untested predictions from synthesis models. Furthermore the ionizing spectra differ significantly between different models, with important implications on widely used emission line diagnostics and other observables.

We here propose to observe for the first time the shape of the ionizing continuum of several star-forming galaxies shortward of (from ~600 to 912 Angstroem) and across the Lyman break. This can be achieved with COS by targeting LyC emitters at z~0.6-0.8. The observations will measure for the first time stellar and nebular emission features in the LyC, and thus provide the first direct constraints for stellar population models in this spectral range.

The proposed observations will provide unique insight on the hardness of the ionizing spectra of star-forming galaxies, with numerous possible implications on our understanding of the emission line properties of distant galaxies, sources of cosmic reionization, emission line diagnostics, and related topics.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16233 |
| Program Title: | Jets and disk scattering - Spatially resolved optical and FUV observations of AA Tau |


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| Principal Investigator: | Christian | Schneider |
| PI Institution: | Universitat Hamburg, Hamburger Sternwarte | |



Planets form during the time, when the central star accretes material from the surrounding circumstellar disk and the final system architecture depends on the poorly known accretion and ejection history. Accretion tracers are particularly prominent in the UV so that the HST legacy program ULLYSES was conceived to obtain a UV atlas of accreting, young stars. In the UV, however, extinction is a severe issue and already moderate amounts of dust can completely extinguish any (accretion) signal. Accretion and extinction decline with age so that it is imperative to understand how well UV observations actually trace genuine accretion emission for higher absorption column densities or if rather other processes, namely jet emission or light scattered towards the observer by the upper disk layers, mimic accretion in spatially unresolved data such as the ULLYSES COS observations.

Our target, the classical T Tauri star AA Tau, currently experiences a long-lasting dimming event, presumably caused by inner disk dust, i.e., the star is currently hidden behind a "natural coronograph" and the direct emission is greatly reduced. Spatially unresolved HST COS data suggest that jet emission and scattering dominate the integrated FUV light during the dimming event. We propose to utilize this situation to detect UV scattering for the first time and to measure the jet's contribution to the FUV light through spatially resolving the emission with a series of STIS long-slit spectra. This experiment, right in time for ULLYSES, will uncover what fundamentally limits UV accretion studies, lack of signal due to absorption or "contaminating" emission spoiling the interpretation of the signals.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Physics and Stellar Types

ID: 16148

Program Title: Painting the first empirical picture of massive stars below the metallicity of the SMC with ULLYSES

Principal Investigator: Peter Senchyna

PI Institution: University of Arizona

Over the last several years, surprising detections of strong high-ionization nebular emission lines in star-forming galaxies ranging in distance from a few megaparsecs to deep into the reionization era have challenged the accuracy of modern stellar population synthesis models. Meanwhile, deep spectroscopy of massive OB stars in the Magellanic Clouds has uncovered increasingly strong evidence that canonical models of stellar evolution may already break down at the moderately-low metallicity of the SMC (20% solar). Both lines of evidence suggest that yet more metal-poor massive stars may be far more abundant producers of hard ionizing radiation than predicted by the latest generation of stellar models; but no direct test of stellar physics in this regime has yet been possible. Fortunately, over the next few HST cycles, the ULLYSES DDT program will help amass the ultraviolet spectra of a statistical sample of massive OB stars at sub-SMC metallicities necessary to conduct such an experiment for the first time. We propose to complete the ULLYSES spectral atlas below 20% solar metallicity with additional UV and optical spectra, and build the accompanying theoretical stellar atmosphere library necessary to constrain fundamental stellar parameters with these data. Leveraging the wealth of UV data ULLYSES will provide in the Magellanic Clouds, we will derive the first robust measurement of the gradient in stellar wind strengths and CNO surface abundances at fixed stellar class down to 10% solar metallicity. This work will provide the crucial framework for calibrating stellar models into the metallicity regime relevant to the interpretation of reionization-era galaxies with JWST.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16184

Program Title: Lyman-alpha Observations of a z=10.15 Powerful Radio Galaxy

Principal Investigator: Nicholas Seymour

PI Institution: Curtin University

Powerful radio galaxies have been unique probes of the distant Universe for many decades. This proposal requests WFC3 grism and imaging observations to characterize the Lyman-alpha break/emission line in a redshift 10.15 powerful radio galaxy. This detection would be by far the most distant super-massive black hole (SMBH) and active galactic nucleus (AGN) known. At this redshift the radio galaxy would lie at the centre of a highly ionised Stromgren sphere ionised by star-formation, inverse Compton emission from the jets, and possibly accretion onto the SMBH. As well as reafirming the redshift of the host, these observations will potentially reveal the complex interaction of this radio-loud AGN with its local environment. Due to the poor transmission of the Earth's atmosphere, Hubble is the only facility which can conduct these observations.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Large Scale Structure of the Universe

ID: 16149

Program Title: Systematics in H_0 from lensing: a comprehensive study of internal structure in elliptical galaxies

Principal Investigator: Anowar Shajib

PI Institution: University of California - Los Angeles

Recently, there has been a strong tension between different measurements of the Hubble constant, H_0. If systematics can be ruled out in these measurements, then this discrepancy will point to new physics either beyond the standard Lambda cold dark matter cosmology, or beyond our current understanding of the galactic/stellar astrophysics. Time-delay cosmography has provided a competitive measurement of H_0 with ~2% uncertainty combining only seven lens systems. However, if the true mass distribution deviates from the power law, the assumption of a power-law mass distribution in the lens galaxies can be a source of systematic in the measured H_0. We will analyze a large sample of galaxy-galaxy lenses that is representative of the time-delay lens population to study the internal structure of the elliptical lens galaxies. We will identify if the mass distribution in these galaxies deviate from (or closely follow) the power law and thus the presence (or absence) of systematic biases in the reported H_0 values from time-delay cosmography. Furthermore, we will provide tight empirical priors for elliptical galaxy structural parameters for use in future time-delay lens analyses.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Large Scale Structure of the Universe

ID: 16150

Program Title: Hubble constant measurement from cluster-lensed quasars

Principal Investigator: Keren Sharon

PI Institution: University of Michigan

We propose to measure the Hubble constant from time delays in three quasars, strongly lensed by clusters of galaxies. Recent measurements of the H_0 show increasing tension between measurements based on the local distance ladder, and those originating from the cosmic microwave background radiation. The discrepancy between these increasingly precise measurements suggests that the systematics of one or both of these measurements are underestimated, or alternatively, calls for new physics. A third method to measure H_0 is from its scaling with the delay between the arrival times of two or more images of a strongly-lensed variable source (Refsdal 1964), and has been implemented in samples of galaxy-lensed quasars. We propose to explore the feasibility of deriving precise H_0 measurements from cluster-lensed quasars. Quasars lensed by clusters are rare; to date, only five large-separation cluster-lensed quasars have been reported. The longer time delays in cluster-lensed quasars mean that the fractional uncertainty in their time delay measurement is at the few percent level. The large separation reduces systematics from microlensing and baryonic physics. On the other hand, the complexity of the cluster lens is likely to make this measurement more difficult. A careful analysis of systematic and statistical sources of uncertainty is called for; this measurement requires Hubble quality data, which is available for three of the five systems. If successful, this study will establish best practices, map and quantify the sources of error due to lens modeling, and pave the road for utilizing new targets that will be discovered in large ongoing and future surveys.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Supermassive Black Holes and AGN |
| ID: | 16171 |
| Program Title: | Understanding the offset in the broad-line region size-luminosity relation with UV spectroscopy |
| Principal Investigator: | Yue Shen |
| PI Institution: | University of Illinois at Urbana - Champaign |

Nearly two decades of reverberation mapping (RM) studies on nearby AGN have revealed a tight correlation between the size of the Hbeta broad-line region and the optical luminosity of the AGN, designated the R-L relation. This correlation is the foundation for the so-called "single-epoch virial black hole mass estimators" that have been widely applied to distant quasars to estimate their black hole masses without dedicated RM measurements. Recent RM measurements for quasars beyond the nearby Universe and for a subset of nearby AGN with estimated high accretion rates have independently revealed a systematic offset from the canonical R-L relation based on the nearby RM AGN sample. The most likely explanation of this offset is that these new RM samples explore AGN that have different accretion rates and therefore different shapes of the continuum spectral energy distribution (SED), responsible for ionizing the line-emitting gas, than the nearby RM AGN sample. We propose STIS UV spectroscopy for a sample of 18 quasars at z~0.4 from one of these recent RM samples to test this hypothesis and to develop empirical corrections to the R-L relation based on additional AGN parameters. We will model the UV spectra with detailed photoionization calculations to constrain the ionizing continuum directly incident on the broad-line region gas. The combination of UV and (existing) optical spectroscopy for a unique non-local AGN sample with direct RM-based black hole masses also will enable better SED-fitting to constrain accretion parameters and better calibrations of single-epoch mass recipes based on UV broad emission lines.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16272 |
| Program Title: | The multiplicity and properties of the LMC WC stars: the immediate progenitors of black holes and stripped supernovae |


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| Principal Investigator: | Tomer Shenar |
| PI Institution: | Katholieke Universiteit Leuven |



Wolf-Rayet stars of the carbon sequence (WC) represent the final evolutionary phase of very massive stars. They are the presumed immediate progenitors of black holes, stripped supernovae (Ibc SNe), and long duration gamma-ray bursts. With 28 WC stars, the Large Magellanic Cloud (LMC) is the only galaxy that hosts a resolvable and statistically significant population of WC stars at subsolar metallicity. Despite this, the physical parameters of most remain unknown, and, in stark contrast to prediction: only 3/28 of the LMC WC stars have been confirmed as binaries. However, previous studies were severely insensitive to year-long orbital periods that WC binaries are expected to exhibit. We propose to obtain single-epoch high-resolution COS/FUV spectra to employ a novel method for binary detection and to derive the wind parameters of the WC population and their potential companions. This will serve as an indispensable step for establishing the highly uncertain onward evolution of very massive stars in the era of gravitational-wave astronomy.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Intergalactic Medium and the Circumgalactic |
| ID: | 16151 |
| Program Title: | On The Rapid Evolution of Galaxy Metallicity Gradients: A Bridge Between Theory and Observations |


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| Principal Investigator: | Raymond | Simons |
| PI Institution: | Space Telescope Science Institute | |



Galaxies form in a complex ecosystem, with metal-rich and metal-poor gas cycling in, out, and around galaxies on rapid timescales. Resolved views of the metallicities of galaxies offer an intimate view into this cycle. The Hubble Space Telescope has enabled rapid progress on this front, but a direct bridge between these observations and theoretical predictions is missing. We propose to investigate the rapid evolution of the spatially-resolved gas metallicities of high-redshift star-forming galaxies using a suite of state-of-the-art hydrodynamical galaxy formation simulations. We will quantify the distinct roles that star-formation, accretion, merging, and radial migration play in (re-)distributing metals within and around galaxies. We will measure the timescales over which these mechanisms act, and search for unique signatures they impart on the metallicity profiles of the simulated galaxies. Critically, we will create synthetic Hubble grism spectroscopy to test predictions from the simulations against real observations. All software, simulation meta-data, and synthetic observations generated from this proposal will be packaged as navigable products and publicly released.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Physics and Stellar Types

ID: 16152

Program Title: Accreting White Dwarfs: Their Masses, Rotational Velocities and Chemical Abundances

Principal Investigator: Edward Sion

PI Institution: Villanova University

Accreting white dwarfs (WDs) in cataclysmic variables (CVs) provide crucial insights about the accretion of mass and angular momentum in all types of binaries including disk accreting NSs and BHs. Accreting WDs are the critical component in the single degenerate pathway to SN Ia and along with the double degenerate merger pathway, they are the standard candles of Cosmology proving that the universe is accelerating and the existence of dark energy. A key question is whether the WD in a CV grow in mass despite the mass loss due to 1000s of nova explosions in its life time. Angular momentum loss drives CV evolution and accreting WDs offer critically needed WD masses and reliable surface temperatures to derive the most accurate accretion rates. However, the number of accreting WDs with masses, accurate rotational velocities and chemical abundances of elements is severely limited, and the only spectral region in which the WD chemical abundances can be determined is the UV because the disk dominates the optical. We propose to fill in poorly sampled regions of the parameter space (accretion rate/Teff vs orbital period) by analyzing a subset of HST archival data for 50 CVs to address the individual masses of accreting WDs in CVs. We will use the newly available Gaia DR2 distances to obtain the WD radii, and use the WD mass-radius law to derive the masses. We will derive the chemical abundances of accreted metals, evidence of metal overabundances and WD rotational velocities. The proposed archival analysis will be a significant leap ahead compared to all earlier analysis of the data and will significantly impact the picture of the evolution of all compact binaries.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16290 |
| Program Title: | UV Spectroscopy of PDS 70: A T Tauri Star Hosting a Newborn Planetary System |


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| Principal Investigator: | Stephen | Skinner |
| PI Institution: | University of Colorado at Boulder | |



Observational studies of planet-hosting T Tauri stars (TTS) provide crucial insight into the earliest evolutionary stages of planet formation at ages of a few Myr. In a exciting new discovery, two giant protoplanets have been directly imaged orbiting in the disk gap of the nearby (113 pc) TTS PDS 70. The gap is gas-depleted, directly exposing the protoplanets to UV and X-ray irradiation from the star. PDS 70 is the closest planet-hosting TTS discovered so far and viewed through very low extinction, making it an exceptional target for UV spectroscopy with HST.

We propose to obtain the first UV spectra of PDS 70 using STIS FUV (G140L) and NUV (G230L) gratings. Our main objectives are to determine the star's accretion rate (which remains controversial) and use the UV spectra, along with existing X-ray spectra, to assess the impact of UV/X-ray irradiation on disk and protoplanet atmosphere ionization and heating. Stellar UV and X-ray emission influence disk dissipation and mass-loss, thus affecting the timescale for planet-formation, a key constraint for planet-formation models.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16185

Program Title: Resolving Star Formation Triggered by M82's Prototypical Superwind

Principal Investigator: Adam Smercina

PI Institution: University of Michigan

Starbursts, and their powerful galactic-scale outflows, are an important mode of galaxy evolution. Yet, owing to their frequently large distances, we understand little about how these starburst-driven outflows operate. Star formation in these outflows, previously observed indirectly using spectral decomposition, and predicted in models, is an as-yet untapped, powerful tracer of the complex physics governing these winds. Resolved star formation triggered within a starburst-driven outflow has now been observed for the first time in M82's prototypical superwind. Deep wide-field imaging has revealed that the wind-induced stellar populations extend in a trail, well beyond M82's disk, displaying an apparent age gradient. This `trail of breadcrumbs' tantalizingly encodes the history of M82's outflow.

As the first-ever detection of this phenomenon, M82's outflow-formed stars present an entirely new lens to study its prototypical outflow, and a singularly unique opportunity to constrain outflow physics. We propose an efficient, 12 orbit coordinated WFC3/ACS survey of M82's trail of star formation in the F475W & F814W filters. This program will allow us to measure the outflow's star formation history (SFH) within the last 300 Myr. Using this SFH, we will place the first-ever stringent constraints on (1) the outflow timescale, (2) the mass outflow history, and (3) the total amount of stellar material contributed by the outflow to the stellar halo. This exquisite dataset will have tremendous legacy potential as a stellar catalog for spectroscopic follow-up, and will serve as a case study of this likely ubiquitous, yet poorly understood, astrophysical process.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16191

Program Title: A Benchmark Survey of Resolved Stellar Populations in the Nearest Ultra Diffuse Galaxy, F8D1

Principal Investigator: Adam Smercina

PI Institution: University of Michigan

Ultra diffuse galaxies (UDGs) --- a remarkable class of low-surface brightness galaxy --- have been recently discovered in large quantities, possessing large physical sizes (>2 kpc), yet low central surface brightness (~25 mag/arcsec^2) and stellar mass (<10^8 M_sun). These galaxies, abundant in groups and clusters, are completely distinct from normal galaxy populations, suggesting formation mechanisms that are unexpected, yet important for galaxy evolution. Substantial HST time has been spent to better understand UDGs as a population. Yet, nearly every known UDG is too distant to resolve their stellar populations, which are likely crucial to understanding their origins. Only one known UDG is close enough to study in detail: F8D1 is a member of the M81 group and only 3.7 Mpc away.

We propose a deep, benchmark survey of F8D1's stellar populations --- a crucial case study of UDG formation physics and of the various models of UDG formation, including tidal processing and unique SFHs. This proposal targets two deep, coordinated ACS/WFC3 fields, as well as a map extending out to larger radii which will allow us to search for faint signatures of tidal disruption. In 31 orbits, we will provide the first-ever measure of a UDG's resolved SFH, as well as its SFH gradient, and will constrain the presence of any tidal signatures within 5*R_eff, down to the deepest-ever (~33 mag/arcsec^2) surface brightness limit. With a fraction of the current HST investment, we will conduct the first `Rosetta Stone' investigation of a UDG. This high legacy-value resolved-star dataset will be key to deciphering the complex potential avenues leading to the formation of these enigmatic galaxies.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16172 |
| Program Title: | The disappearing LBV in the low metallicity galaxy PHL293B: Collapse to a black hole? |


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| Principal Investigator: | Nathan | Smith |
| PI Institution: | University of Arizona | |



The metal-poor dwarf galaxy PHL293B (23 Mpc) contained a luminous blue variable (LBV) candidate that was identified based on its spectrum. This source was detected at roughly constant luminosity during 2001-2009, modeled as a massive LBV with log(L/Lsun)=6.4-6.7. This is similar to eta Carinae, and notably, similar to the progenitors of SN2009ip and SN2015bh. In more recent data, the source has faded beyond ground-based limits, and spectral signatures of the LBV are now gone. A massive LBV-like star at roughly 0.1 Z solar provides important clues for understanding the role of eruptive mass loss at low metallcity, and the star's recent disappearance may hold critical clues about the fate of such stars. The sudden fading in the last decade could be the result of either the end of a giant LBV eruption, or it could be the death of a very massive star when it collapsed to a black hole with no bright supernova. To rule out the second hypothesis, we would need to detect the surviving star, but ground-based data cannot do this because the source is too faint and lost in galaxy light. There are two plausible scenarios for a surviving star: (1) When the LBV eruption ended, the star faded in the optical because it got hotter, shifting its energy distribution into the UV, or (2) it faded at visual wavelengths because it formed dust, in which case the star should still be detectable in the near-IR. We propose deep imaging with WFC3 UVIS and IR to either detect the surviving star in the UV/optical/IR, or to confirm that it has vanished to deep limits. If it is gone, this would be the first secure case of a very massive star that vanished to a black hole.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16273 |
| Program Title: | Andromeda and the Seven Dwarfs: M31 Mass, Satellite Orbits, and the Nature of the Satellite Plane |
| Principal Investigator: | Sangmo Sohn |
| PI Institution: | Space Telescope Science Institute |

Proper motions (PMs) from HST and Gaia have revolutionized the field of Galactic archaeology in the Milky Way (MW), but PM studies in the M31 system are still in their early stages. Gaia can only detect the brightest stars in star forming regions at the distance of M31, so HST is the only observatory currently capable of measuring PMs of M31 satellite dwarf spheroidals. We propose to obtain second epoch imaging of 7 M31 satellites (And I, II, III, VII, XV, XVI, XXVIII), targeting the same fields with earlier deep HST observations to measure PMs with uncertainties of 40-50 km/s. We will use the PM-based 6D phase space information of satellites to constrain the total M31 mass with uncertainties at the 30% level. We will also test the dynamical stability of the Great Plane of Andromeda using our PM results for And I, III, and XVI. This will provide clues to the origin of satellite planes observed around M31 as well as the MW. The orbits derived for individual satellites will allow us to disentangle the processes that have contributed to the quenching of star formation, connect our target galaxies to M31 tidal structures, and test the merger scenario of And II. Altogether, our proposed measurements will nearly triple the sample of M31 satellites with available PMs, dramatically improving our understanding of the M31 halo and its satellite system. A revised estimate for the mass of M31 will also improve our understanding of the dynamics in the Local Group (LG), and set an important benchmark for studies of satellite systems beyond the LG. Finally, the results from this program will inform us how representative the MW is in a cosmological context.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16274

Program Title: Resolved Proper Motions of M33

Principal Investigator: Sangmo Sohn

PI Institution: Space Telescope Science Institute

As the only low-mass disk galaxy in the Local Group, M33 is one of the most important and best-studied galaxies on the sky. It is also one of the most confusing: since it is nearly bulgeless, it is unclear what makes it stable to formation of a strong bar. One stabilizing factor may be the existence of dynamically hot components such as a thick disk or halo, but these have long been controversial and hard to detect. Recent individual-star spectroscopy now gives clear evidence of a halo component, but its structural properties, its origin, and its dynamical effects are not yet clear. We propose to use proper motions with 16-year baselines to measure the kinematics of stars in five fields at the edge of the M33 disk. We will probe the relative rotational lag of the hotter components (the halo and a possible thick disk) versus the young, thin disk. We will measure the dispersions in the planar and vertical directions separately, using dispersions measured directly from proper motions as well as the correlation between the proper motions and LOS velocities from spectroscopy. We will check the halo for non-equilibrium flows indicating a possible origin in a recent merger. We will also provide an independent and more precise measurement of M33's center-of-mass proper motion. These observations are only feasible now because of the longevity of HST. They will yield a dataset completely unique in nature for any galaxy like M33, which will shed new light on the structure and dynamical history of this important galaxy.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16153

Program Title: M-dwarf Exoplanet Direct Detection using Light Echoes (MEDDLE)

Principal Investigator: William Sparks

PI Institution: SETI Institute

We seek to directly detect exoplanets orbiting M dwarf stars using light echoes from stellar flares, leveraging Doppler shifted line emission and echo time delays to greatly enhance the exoplanet detectability. With a massive investment of HST time into M dwarf UV observations in recent years, we propose to extract all archival UV time-resolved COS and STIS spectroscopy of M dwarfs. We will seek echoes of flares from their planetary Doppler shifted spectra and time delay, and quantitatively assess the feasibility of this approach. If validated, light echoes present a detection and characterization opportunity complementary to and decades ahead of that offered by flagship-scale space telescopes such as LUVOIR, sensitive to a region of discovery space which is extremely difficult to access even for LUVOIR. The sheer numbers of M dwarfs and their proximity means they are by far the most likely to host the nearest habitable extrasolar planets. While JWST may be able to characterize the atmospheres of a small number of transiting M dwarf planets, only a tiny fraction of planets actually transit. All exoplanets orbiting active stars, however, are potentially observable using light echoes, and most M dwarfs are active at some level. The observable quantities can completely define the orbit, yield estimates of size and albedo, and identify exoplanet atmospheric lines. Hence this offers an opportunity for the detection and characterization of one of the most important classes of exoplanet: habitable, nearby, numerous. A by-product of the study will be a comprehensive overview of flare properties on M dwarf stars, enhancing our understanding of the UV environment and habitability.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Intergalactic Medium and the Circumgalactic |
| ID: | 16248 |
| Program Title: | Testing the Origin and Consequences of Vast Extended Molecular Gas Outside High-Redshift Post-Starburst Galaxies |


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| Principal Investigator: | Justin Spilker |
| PI Institution: | University of Texas at Austin |



We have discovered spectacular vast molecular gas reservoirs reaching tens of kpc outside of two high-redshift post-starburst galaxies as part of an ongoing ALMA survey of such objects. While the host galaxies are only 3-5kpc in size, nearly half the total molecular gas in each system extends 25-45kpc from the hosts. This discovery was unexpected and both the scale and magnitude of the extended gas features are unprecedented at any redshift. The origin of the highly extended molecular gas we have discovered is unclear, but may be related to AGN outflows, stripped tidal tails, and/or material cooled from hotter circumgalactic gas - the spatial resolution and sensitivity of HST are needed to distinguish which. We propose an efficient, high-impact program using WFC3 G102 slitless spectroscopy and F105W direct imaging to determine the origins of the remarkable gas features and their broader implications for galaxy evolution, including galactic feedback, the formation of extended stellar halos, and circumgalactic metal enrichment. These observations are designed to detect and resolve in-situ star formation within the extended gas features, identify stellar tidal debris and close-in merging companions, and spectroscopically map out the local environment on 1Mpc scales. Together, the combination of direct imaging and slitless spectroscopy can uniquely determine the origin of the incredible molecular gas structures we have found and place this unexpected discovery in broader context.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Stellar Physics and Stellar Types |
| ID: | 16154 |
| Program Title: | Optimal Use of HST for Obtaining Statistical Constraints for SN IIb Progenitors and their Companions |


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|---|---|---|
| Principal Investigator: | Niharika | Sravan |
| PI Institution: | Purdue University | |



The mechanisms driving removal of envelopes of stripped-envelope supernova (SE SN) progenitors is a key challenge to our understanding of massive star evolution. Type IIb SNe (SNe IIb) are particularly valuable for addressing this challenge because of the availability of direct progenitor/companion identifications in several cases. HST archives are the primary source of these fortitutous pre-SN images and provide the strongest constraints for theoretical models. Unfortunately, current methods for using HST photometry to constrain progenitor properties and understanding their evolutionary mechanisms do not account for the statistical significance of either the observational data or model progenitors. This severely limits both the diagnostic and predictive capabilities of theoretical models. Moreover, differences in assumptions for data reduction by different groups causes variation in inferred progenitor properties for the same data.

We propose to conduct a homogenous analysis of archival HST images of all SN IIb with detected progenitors and derive statistical constraints for their progenitor and companion properties. Our analysis will also provide predictions for progenitor and companion properties in HST filters to aid in companion searches. We will release to the community all codes required to reproduce our analysis for any future SN IIb on the successful completion of our project. Such a tool will significantly aid and simplify efforts for understanding SNe IIb progenitors. Given HST's degrading UV sensitivity, such a tool is not only time-critical but also essential in order to make optimal use of HST's unique UV capabilities.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16202

Program Title: Revealing Structure in the HD 53143 Debris Disk

Principal Investigator: Christopher Stark

PI Institution: Space Telescope Science Institute

The solar analog star HD 53143 hosts a tenuous disk of cold material analogous to a more massive version of our solar system's Kuiper Belt. Puzzlingly, unlike every other debris disk observed thus far, existing low-S/N visible wavelength images of HD 53143 show that the micron-sized dust around HD 53143 does not resemble a circumstellar ring--rather, it looks like two isolated clumps of material. New ALMA observations show that the underlying distribution of larger planetesimals is indeed ring-like, but very eccentric and mis-aligned with the visible wavelength clumps. Further, the ALMA observations reveal 5-sigma excesses just interior to the circumstellar ring, suggesting structure in the planetesimal population that may be connected to the visible wavelength clumps. We propose high-S/N coronagraphic imaging of HD 53143 using HST STIS to reveal the peculiar nature of this unique debris disk and search for signs of planet-induced disk structure or collisional activity. In addition to revealing the structure of the disk, these high-S/N images will allow us to measure the optical properties of the debris disk dust to constrain its composition, size distribution, and provide critical measurements of debris disk properties that will inform future exoplanet-imaging missions.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16275

Program Title: Compact binary mergers: R-process kilonovae and ultra-relativistic jets

Principal Investigator: Nial Tanvir

PI Institution: University of Leicester

The discovery of a gamma-ray flash and kilonova (KN; aka. macronova), AT2017gfo, associated with the first binary neutron star (BNS) merger detected by aLIGO/AdV, GW170817, heralded the era of GW+EM multi-messenger astronomy. This landmark event confirmed both the association of short GRBs with binary mergers, and that neutron star material can be ejected in sufficient quantities to power a detectable radioactive transient. It opened a new window on several long-standing problems in astrophysics, cosmology and fundamental physics, including the possibility that BNS and NSBH compact binary mergers represent the dominant source of heavy r-process elements in the universe. However, the lack of success in identifying similar events in the O3 run of the gravitational wave detector network so far has highlighted that their rate is low in the nearby universe (e.g. d<200 Mpc), thus opportunities for intensive study of kilonovae, crucial to understanding their heavy element yields, for example, will be infrequent. Here we propose a ToO campaign targeting a kilonova discovered during cycle 28. This is between the GW network science runs, but KNe may still be found in blind surveys, accompanying short-GRBs, or during GW engineering runs. HST has already made unique contributions to the follow-up of AT2017gfo and its off-axis relativistic jet, and also provided the primary evidence for the most compelling cases of KNe following SGRBs. Our program is flexible to adapt for different possible scenarios, and will be crucial for understanding the diversity of EM signatures from neutron star compact binary mergers, and providing the data to test increasingly sophisticated KN models.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16155

Program Title: Do Starbursts Form Cored Density Profiles in Dwarf Galaxies?

Principal Investigator: Grace Telford

PI Institution: Rutgers the State University of New Jersey

It is widely accepted that starbursts can dramatically affect their host galaxies via feedback-driven outflows, especially for gas-rich dwarfs with shallow potential wells. The removal of gas from a galaxy's center is predicted to change the gravitational potential, causing "cuspy" cold dark matter (CDM) density profiles to transform into constant-density "cores." Recent hydrodynamical simulations have identified this mechanism as a potential solution to the long-standing core-cusp problem in CDM cosmology, and further predict that cusps can reform within a few 100 Myr post-burst as gas cools and collects in the galaxy center, creating the conditions for another starburst.

We propose a novel, direct test of how feedback from starbursts impacts dwarf galaxy dynamics. We have assembled a sample of nearby dwarf galaxies spanning a range of central density profiles from cuspy to cored, determined from high-quality HI rotation curves, that have archival HST imaging of resolved stars suitable for deriving recent star formation histories (SFHs). We will identify current and recent starbursts and measure their timing, duration, energetics, and spatial extent across our sample, which is large enough to include diverse recent SFHs. With galaxies at a range of times post-burst, we will statistically sample the time evolution of central density profiles following a starburst and test the hypotheses that (1) cored galaxies are post-starburst, and (2) cusps reform on timescales comparable to the dynamical time. This study will probe the fundamental connection between starbursts, gas, and dark matter and provide an observational test of the favored solution to the core-cusp problem.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Physics and Stellar Types

ID: 16156

Program Title: UV spectra of Type Ia Supernovae from Double Detonations

Principal Investigator: Dean Townsley

PI Institution: University of Alabama

Type Ia supernovae (SNe Ia) have inspired and baffled observers throughout the documented history of their occurrences. Despite frequent observations and fervent studying throughout the past, the true origin of these highly luminous events is still a great mystery. While it is generally agreed upon that a SN Ia is a thermonuclear explosion of a carbon/oxygen white dwarf within a binary system, the precise progenitor systems and explosion mechanisms that generate these supernovae are not well known. A promising explosion mechanism that has recently come to the fore for a significant share of observed SNe Ia is the double detonation. This mechanism, while promising, has received little study via computation of its UV spectral characteristics. We propose to conduct a series of 2D simulations of double detonations in carbon/oxygen white dwarfs with a thin shell of helium, with progenitors varying in both mass and metallicity. Through comparison of the predicted UV spectra to those previously observed with HST, we aim to address the viability of the double detonation scenario and how metallicity affects observables in this model.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Supermassive Black Holes and AGN |
| ID: | 16173 |
| Program Title: | Hyperfine Temporal & Spatial Resolution of Stellar Ages amid Quasar-Driven gas flows: Unifying HST with MUSE and ALMA |
| Principal Investigator: | Grant Tremblay |
| PI Institution: | Smithsonian Institution Astrophysical Observatory |

The Close AGN Reference Survey (CARS; www.cars-survey.org) has assembled a rich, hyperdimensional dataset for 33 nearby Type 1 AGN, anchored by VLT/MUSE IFU datacubes for every target, along with pan-chromatic complementary datasets including ALMA for a large subset of the sample. We now propose an orders-of-magnitude increase in the spatial and temporal resolution of young stars and their ages (respectively) for the entire sample. The proposed WFC3/UVIS UV imaging will map sites of very recent star formation along multiphase quasar-driven outflows, instability-driven gas inflows, and merger-driven tidal interactions, testing whether each might lead to the suppression or even triggering of star formation. It is, therefore, a direct test of both negative and positive black hole feedback models.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Large Scale Structure of the Universe

ID: 16249

Program Title: A Cool White Dwarf Network as a Precise Flux Reference for Dark Energy Surveys

Principal Investigator: Pier-Emmanuel Tremblay

PI Institution: The University of Warwick

A quantitative description of dark energy is assembled from observations of supernovae Ia at different redshifts. The fluxes of supernovae are compared with nearby supernovae in the rest frame, thus accurate relative flux with wavelength calibration is critical to understand the nature of dark energy. The dominant systematic error in measuring relative fluxes is currently from uncertainties in the flux of stellar standards. Our proposal will directly address this critical barrier.

We propose STIS and WFC3 low resolution observations that will lead to a network of 16 cool (Teff < 20,000 K) white dwarfs. This will provide a new set of primary flux standards that is expected to have higher accuracy at near-IR and IR wavelengths compared to the currently most precise set of fluxes which comes from HST spectrophotometry of three hot white dwarfs (Teff > 30,000 K). Our program will provide the legacy for flux calibration of near-IR and IR instruments onboard future missions such as JWST, Euclid and WFIRST. We also expect that our network will lead to an accuracy of <0.5% on the wavelength-dependent flux calibration in the optical (ground or space), increasing by a factor of two the precision on the luminosity of the tens of thousands of supernovae Ia to be detected from LSST.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Supermassive Black Holes and AGN |
| ID: | 16291 |
| Program Title: | Spatially Resolving Outflows in a z~1 Extremely Red Quasar to Observe a Short-Lived Blowout Phase in Galaxy Evolution |


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| Principal Investigator: | Christy | Tremonti |
| PI Institution: | University of Wisconsin - Madison | |



A key question in galaxy formation is how active galactic nuclei (AGN) interact with their host galaxies. Extremely Red Quasars (ERQs) are ideal objects to study this interaction since they are believed to be quasars caught in a short-lived phase where they are actively clearing gas from their host galaxy's central regions. Most known ERQs are at z=2-3, making it challenging to resolve details of their winds and host galaxies, even with HST. Here we propose to study the lowest redshift ERQ discovered to date (z~0.94) with the aim of directly resolving the high ionization outflow using narrow-band imaging of the [Ne V] line. The narrow band observations will provide a first look at the size and spatial distribution of a powerful quasar outflow during this key phase. The broad band observations will enable measurement of the host galaxy properties including Sersic index, evidence of merging, and recent (100 Myr) star formation. J0048-0046 provides the best possible chance to constrain the ionized gas outflow size of an ERQ, both due to its low redshift and its high level of nuclear obscuration. With the derived outflow size measurements, we can test our theories of galaxy formation and measure whether ERQ winds have enough kinetic power to blow the gas out of their hosts. These observations will also help contribute to building up a sample of ERQ hosts and outflow measurements that can be used to assess how ERQs outflows are driven and how the hosts of these galaxies evolve.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: SNAP

Scientific Category: Large Scale Structure of the Universe

ID: 16262

Program Title: 5% Distances to Galaxies using Surface Brightness Fluctuations

Principal Investigator: R. Tully

PI Institution: University of Hawaii

Surface brightness fluctuations in E/S0 galaxies are sufficiently bright in the infrared that they can be recorded with high signal-to-noise in galaxies within 80 Mpc in a single HST orbit. The SBF luminosity dependence on metallicity and age tracked by color is well established, permitting measurements of individual distances accurate to 5%. This outstanding capability will be used to determine distances for SNAP targets drawn from every massive cluster and the most important E/S0 galaxies outside of massive clusters within 80 Mpc. Galaxy-galaxy and galaxy-cluster comparisons with elliptical fundamental plane, spiral luminosity-linewidth and, especially, supernova distances will be made whereever possible in order to evaluate random and systematic uncertainties. SBF can provide distance measures for the cosmological measurement of H0 comparable in accuracy to those of SNIa. SBF anchored by the tip of the red giant branch zero point offers a competitive and independent alternative to the Cepheid/SNIa route to H0.

The most massive clusters at 40-80 Mpc lie within either the so-called Great Attractor region or the Perseus-Pisces filament. This range is the sweet spot for HST IR SBF studies - distances too great to be reliably measured from the ground but comfortably accessable with HST in single orbits. The dynamics in these two complexes are in the strongly non-linear regime with clusters collapsing toward each other. Numerical action methods will permit the recovery of physical orbits and the determination of masses. The 3D information on positions and motions affords a unique window into the construction of rich clusters.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Physics and Stellar Types

ID: 16203

Program Title: Early Ultraviolet Spectroscopy of a Nearby Supernova

Principal Investigator: Stefano Valenti

PI Institution: University of California - Davis

We propose for an ultra-rapid, disruptive ultraviolet (UV) spectroscopic sequence of one nearby SN discovered within ~12 hours of explosion and within the TESS footprint. We will combine these observations with a rapid response, high cadence Swift UV light curve, along with a comprehensive optical+NIR ground-based campaign. This data set will offer an unique view of the explosive shock breakout of the SN explosion, companion star interaction, and the last phases of massive star evolution.

At early times, our understanding of SN progenitors usually comes from extrapolations from the optical, where less than 1% of the light is. Only UV spectroscopy will allow us to put firm constraints on the luminosity, the temperature and the metallicity of the progenitor. For core collapse SNe, the early temperature evolution can constrain the progenitor radius or extended envelope. The UV light, or the SN ejecta, can ionize the surrounding circumstellar medium (CSM) and can constrain the progenitor star's metallicity, wind speed and CSM extent. For type Ia SNe, recent very early light curve excesses point to shocking with a normal companion star, CSM interaction or an unusual nickel distribution, but models cannot reproduce UV light curves, and only spectroscopy will reveal the progenitors of these essential cosmological tools.

A concurrent TESS light curve for this UV spectroscopic sequence will pinpoint the moment of explosion and act as an additional probe of CSM/companion star interaction.

Very early UV spectroscopy of a nearby SN is a completely unique observation that only HST can provide, and the SN community may not have this opportunity again for the foreseeable future.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Galaxies |
| ID: | 16186 |
| Program Title: | The extremely peculiar globular cluster system of UDG GAMA-526784 and its implications |


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| Principal Investigator: | Remco van der Burg |
| PI Institution: | European Southern Observatory - Germany |



Recent observations of Ultra-Diffuse Galaxies (UDGs, which have the luminosities of dwarfs but sizes of giant galaxies) have picked up a lot of attention by the community. Two nagging problems that are being discussed in the context of UDGs, are 1) the apparent lack of dark matter of some UDGs, and 2) their anomalously abundant-and-bright globular cluster systems. The former is difficult to reconcile with a LCDM model of structure formation, while the latter is contrary to what we observe in essentially any other galaxy system. We have recently discovered a UDG candidate, that may provide valuable insight towards solving both problems. This object has very similar properties to typical UDGs, apart from a widely spread population of compact star-forming regions. Our ground-based photometry indicates that these regions have stellar masses similar to globular clusters (GCs), and at least three have radial profiles that are unresolved by our ground based imaging - in line with expectations for young massive clusters. The HST brings the high spatial resolution, and imaging capability in the near-UV, that are required to better constrain the physical sizes and formation ages of these compact regions. Interestingly and coincidentally, some properties of this galaxy are strikingly similar to those hypothesised by Silk 2019, who predicts the simultaneous formation of massive GCs, and links this to the formation of UDGs that lack dark matter and exhibit extreme GC systems. This UDG may just provide us a very rare local view on such processes in action.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16157

Program Title: Evolution of the kinematical properties of multiple stellar populations in globular clusters

Principal Investigator: Enrico Vesperini

PI Institution: Indiana University System

Spectroscopic and photometric observational studies have provided strong evidence of the presence of multiple stellar populations in many globular clusters (GCs). HST is playing a central role in all the aspects of the study of multiple-population GCs. Recent HST-based high-precision proper motion studies are now adding another fundamental ingredient to the observational study of the dynamical properties of GCs and shedding light on the differences between the kinematical properties of different stellar populations.
We will carry out an extensive survey of N-body simulations to explore the evolution of the kinematical properties of multiple-population GCs and identify the detailed kinematical fingerprints of their possible formation and dynamical histories.
Our investigation will address a number of fundamental questions concerning the effects of dynamical evolution on the kinematical properties of different stellar populations, the implications of the differences in the initial spatial distributions of different stellar populations for the evolution of their kinematical properties, the effects of the external Galactic tidal field for clusters on different orbits, and the dependence of the kinematical properties on the stellar masses.
Our study will build the theoretical framework necessary to interpret and guide HST kinematic studies of multiple populations and provide the theoretical tools to leverage these studies to test the viability of different multiple-population formation scenarios.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16174

Program Title: Imaging Planet-Disk Interactions in the Beta Pictoris Disk

Principal Investigator: Kevin Wagner

PI Institution: University of Arizona

Debris disks are readily detectable tracers of embedded planetary systems; however, their complex internal structures are often challenging to interpret as most debris disks do not harbor known exoplanets. The prototypical debris disk around Beta Pic and its two relatively short-period super-Jupiter planets offer a unique laboratory for studying planet-disk interactions. Five mechanisms have been identified through models in which Beta Pic b may shape the complex disk structure and may perturb planetesimals into an inclined orbit, giving rise to the secondary disk discovered with HST. Structures shaped by the planet's resonances can introduce large-scale azimuthal asymmetries in the disk that orbit on timescales similar to that of the planet (~18 yr). With STIS images from 1997 and 2012 a uniquely long baseline is available for identifying the temporal evolution of the disk, which is predicted to evolve on comparable Keplerian timescales. We propose to revisit and continue monitoring the Beta Pic disk with STIS to characterize the temporal evolution of the disk. By repeating the earlier observations we will detect variations as small as 1% at 0.5". In comparison, models of radiation-pressure driven small grains freed from planetesimals trapped in resonance with the planet predict variations up 300% in this component. We will identify disk structures and dust grain populations that are a result of interactons with the two giant planets, directly testing models explaining the disks' complex structure. These observations will provide an entirely new set of constraints on the 3D structure and dynamics of the only known disk/planet system where such measurements are possible.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Intergalactic Medium and the Circumgalactic

ID: 16158

Program Title: The metallicity of high- and intermediate-velocity clouds

Principal Investigator: Bart Wakker

PI Institution: University of Wisconsin - Madison

We propose to use HST-COS spectra to conduct a comprehensive survey of the metallicities of high- and intermediate-velocity clouds (HVCs/IVCs). These objects serve as test particles for modeling Galactic phenomena, such as the Galactic Fountain, tidal streams and accreting low-metallicity gas. The properties of the latter type also appear similar those of intergalactic gas clouds seen in QSO absorption lines, and thus may hold clues to understanding the IGM. HVC and IVC metallicities have been measured in ~25 sightlines for ~5 complexes and a few smaller clouds. The HST archive contains many unanalyzed spectra serependitiously intersecting many other HVCs and IVCs. As the oxygen/hydrogen and sulphur/hydrogen ratios are only weakly affected by dust and ionization effects, we will use the OI-1302 and SII-1250/1253/1259 lines in 200 spectra to measure the metallicity in 11 different cloud complexes (pierced by 5-50 sightlines) and about 50 individual smaller clouds. The resulting metallicities will allow us to identify the origin of each cloud and even study metallicity variations across some large clouds. Combined with the HVC/IVC distances and an understanding of their motions, we can then determine flow rates for the Fountain and for infall, as well as determine the extent of the Leading Arm of the Magellanic Stream, which will constrain recent improvements in modeling.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Supermassive Black Holes and AGN |
| ID: | 16187 |
| Program Title: | Mapping A Distant Protocluster Anchored by A Luminous Quasar in the Epoch of Reionization |
| Principal Investigator: | Feige Wang |
| PI Institution: | University of Arizona |

Theoretical models predict luminous quasars should reside in the most massive dark matter halos acting as signposts for large overdensities of galaxies in the young Universe. But despite two decades of searching, proto-clusters traced by quasars have not yet been uncovered in the epoch of reionization (EoR). Recent ALMA/JCMT sub-mm observations and Subaru narrow/broad band imaging of a luminous quasar at z=6.63 have revealed a spectacular overdensity of [CII] emitters, sub-mm galaxies (SMGs), and Lyman alpha emitters (LAEs), suggesting that it is the the most distant known proto-cluster harboring quasar activity, and the first such system discovered in the EoR. With two HST pointings we will map the inner region of this large scale structure, covering the quasar, six [CII] emitters, two LAEs, and seven SMGs. The high-resolution WFC3 images will measure the spectral energy distribution and the sizes of these galaxies, and resolve two putative galaxy merger systems. It will also enable accurate PSF subtraction to study the assembly of the massive and very large (>1 arcsec, from ALMA) quasar host galaxy. On larger scales, the combination of HST and Subaru deep imaging will identify more than 20 Lyman-break galaxies (LBGs) at z~6.6, and reveal the distribution of star forming galaxies. These rest-frame UV HST observations will trace the unobscured star formation, highly complimentary to the dust and gas emission traced by ALMA and JCMT. In addition, our proposed observations provide data essential for planning future JWST NIRSpec/MSA and IFU observations of this unique system to understand galaxy formation and evolution in the densest environments in the EoR.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Galaxies

ID: 16276

Program Title: WFC3 Spectroscopy of the Most Massive Galaxy Protoclusters at Cosmic Noon

Principal Investigator: Xin Wang

PI Institution: California Institute of Technology

We propose to obtain WFC3/G141 grism observations in the density peak regions of three massive protocluster fields at z=2-3, selected using coherently strong Lyman-alpha absorption from the IGM in background quasar spectra. These three protoclusters were selected using the SDSS-III quasar library of >80,000 spectra over a sky coverage of 10,000 deg^2. They have over 100 spectroscopically confirmed bright Lyman-alpha/H-alpha emitters in each system and are among the most massive protoclusters yet known at high redshifts. Previous HST imaging data have revealed a tentative population of red and compact galaxies, whose general faintness precludes ground-based spectroscopic confirmation. The WFC3/G141 grism provides the only way to efficiently confirm the redshifts of these passive galaxies through spectral features typical of old stellar populations. The goals of this proposal are: 1) to confirm the protocluster membership of red galaxies, and the redshifts of faint Lyman-alpha/H-alpha emitter candidates; 2) to characterize the stellar populations of quiescent and post-starburst galaxies, and compare the relative strengths of different quenching mechanisms (mass/internal vs. environment/external); 3) to spatially resolve the chemical profiles of the protocluster member star-forming galaxies, and measure metallicity radial gradients in a large sample of ~100 galaxies in overdense environments. The proposed observation will establish the first statistically significant benchmark for the cluster-field comparisons in the aspects of galaxy mass assembly and chemical enrichment, and provide key insights on the early evolution of the progenitors of Coma-like galaxy clusters at z~0.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16159

Program Title: Measuring the Cosmic Star Formation History of the Lowest Mass Galaxies

Principal Investigator: Daniel Weisz

PI Institution: University of California - Berkeley

Over the past two decades, thousands of HST orbits have been dedicated to measuring the star formation history (SFH) of the Universe. However, the resulting, ubiquitously-used cosmic SFH is only valid for fairly massive galaxies (M_UV < -17) at all redshifts. At low redshift, it neglects the contribution of galaxies less massive than the SMC; at high redshifts, it misses galaxies fainter than Milky Way progenitors. These galaxies are simply too faint to be reliably identified outside of the local Universe. Here, we propose to use archival ACS/WFC3 optical color-magnitude diagrams (CMDs) of 67 Local Group (LG) dwarf galaxies and state-of-the-art cosmological simulations to measure the cosmic SFH of galaxies less massive than the Magellanic Clouds. HST has invested hundreds of orbits in collecting CMDs that reach the oldest main sequence turnoff (MSTO) throughout the LG, enabling the measurement of detailed SFHs back to the reionization era. We will use this rich archival dataset to (1) construct the cosmic SFH for low-mass galaxies and compare it to the widely used high-redshift version; (2) determine the mean-metallicity history of low-mass galaxies; and (3) measure the faint galaxy luminosity and mass functions across cosmic time. For each goal, we will use cosmological simulations to account for completeness, the changing volume of the LG across time, and accretion of dwarf galaxies onto more massive systems (and the subsequent destruction of some of these dwarfs). This archaeological approach in the LG is the only way to measure the cosmic SFH of low-mass galaxies, as they are simply too faint to be detected at the relevant redshifts, even in the JWST-era.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16263

Program Title: Diagnosing a New Species of Dusty Debris: the Chameleon Debris Disk

Principal Investigator: John Wisniewski

PI Institution: University of Oklahoma Norman Campus

Two new, potentially causally correlated, observational phenomena have recently been discovered in spatially resolved imagery of debris disks: outward moving features traveling at super-Keplerian velocities and changes in the color of the AU Mic debris disk. To date, these are the only moving structures and the only observed color change seen in spatially resolved debris disks. We propose to use the only observational facility capable of yielding high fidelity optical coronagraphic spectroscopy of AU Mic's disk, HST/STIS, to obtain second epoch G750L and first epoch G430L spectroscopy. These data will enable us to: a) quantify color changes in the disk over a 2x greater time baseline (16 yrs) than previously achieved; b) determine whether the disk's color between 30-45 au continues to change as additional fast moving features pass by; c) better quantify the size of dust grains whose spatial distribution has changed; and d) confirm and better quantify whether small grains populate small (10-30 au) stellocentric distances. Derived grain size distributions will be linked to dynamical models proposed for the origin of fast moving features in this system.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Galaxies |
| ID: | 16175 |
| Program Title: | Can Very Massive Stars form at the low-metallicity threshold of the nearby Universe? |


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| Principal Investigator: | Aida | Wofford |
| PI Institution: | Universidad Nacional Autonoma de Mexico, Obs. Astron. Nac. | |



Very massive stars (VMS, >100 Msun) dominate the ionization and mechanical feedback in star-forming regions for the first few Myr. Evidence for VMS has been found from UV observations of young (< 3 Myr), massive star clusters (>5x10^4 Msun), in the LMC and two nearby starbursts. Larger samples of these stars are needed in order to determine the upper mass limit of the IMF and complete our understanding of massive star evolution. In addition, since JWST will obtain numerous UV rest-frame spectra of young high redshift galaxies, it is essential that we investigate whether VMS are common in local, low metallicity analogs, while we still have access to the UV domain. SBS 0335-052E is one of the nearest most metal-poor analogs and contains several super star clusters (SSC) of 10^5 M_sun. From ground-based optical spectroscopy, candidate Wolf-Rayet (WR) have been found in cluster 3 of the galaxy (SSC3). Given its young age, large mass, and WR-like signatures, SSC3 could host VMS. We request co-spatial STIS G140L UV + G430L optical 52x0.2 long-slit spectroscopy of SSC3 in SBS 0335-052E. The requested observations will cover the high-ionization UV emission lines of C IV, He II, and O III], and the optical He II 4686 line. Dust attenuation will be obtained from the UV to optical He II ratio. We will use the co-spatial UV + optical data to test if WR stars alone can explain the observed properties of SSC3 or if VMS are necessary. The observations will provide important constraints to state-of-the-art spectral synthesis models of the kind that will be used to interpret rest-frame UV spectra of the most distant galaxies, with future large telescopes.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Intergalactic Medium and the Circumgalactic

ID: 16317

Program Title: A Quantitative HeII Lyman Alpha Absorption Spectrum of the Newly Discovered Highest-Redshift UV-bright Quasar

Principal Investigator: Gabor Worseck

PI Institution: Universitat Potsdam

The advent of GALEX and COS have revolutionized our view of HeII reionization, the final major phase transition of the intergalactic medium. Efficient COS surveys have provided a statistical sample of strongly fluctuating HeII Lyman alpha absorption at 2.7<z<3, evoking a picture of overlapping HeIII zones around quasars at the end of HeII reionization. Unexpectedly, the seven rare quasars probing z>3.5 have revealed a set of HeII transmission 'spikes' and larger regions with nonzero transmission that suggest HeII reionization was well underway by z=4. This is in striking conflict with 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. A recent survey for high-redshift quasars in the southern hemisphere has uncovered the highest-redshift far-UV-bright quasar known (z=3.95, FUV=21.7). We propose here for COS G140L follow-up spectroscopy to (i) confirm its utility for HeII absorption studies by identifying possible interloping low-z HI absorbers, (ii) provide accurate measurements of the HeII Lyman alpha effective optical depth that are limited by systematics for much fainter already observed quasars, and (iii) constrain the lifetime of the background quasar from its ionized proximity zone. Moreover, the proposed observations would provide only the third z>3.5 sightline that would allow for high-resolution G130M spectroscopy before the end of HST's mission.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Supermassive Black Holes and AGN

ID: 16318

Program Title: The First Measurement of the Distribution of Quasar Lifetimes with the HeII Proximity Effect

Principal Investigator: Gabor Worseck

PI Institution: Universitat Potsdam

The duration of quasar (QSO) accretion episodes is a key quantity for distinguishing between models for the formation and growth of supermassive black holes, QSO evolution, and the potential feedback effects on their host galaxies. However, this critical timescale, often referred to as the QSO lifetime, is still uncertain by orders of magnitude t_Q~10^4-10^9 yr. The intense UV radiation from a QSO dramatically alters the ionization state of its surrounding intergalactic medium (IGM), which is observable as enhanced Lyman-alpha transmission toward the QSO in its so-called proximity zone. HST/COS spectra of far-UV bright QSOs probing the HeII Lyman-alpha forest provide a unique opportunity to make precise lifetime measurements for individual QSOs. Indeed, the size of the HeII proximity zone depends sensitively on the QSO lifetime for t_Q<30 Myr, comparable to the e-folding timescale for SMBH growth t_S=45 Myr. We have compared the sizes of HeII proximity zones to theoretical models generated by post-processing cosmological hydrodynamical simulations with 1D radiative transfer, which allows us to measure individual QSO lifetimes to 0.2 dex precision. An analysis of 24 archival HST/COS spectra has revealed a surprisingly broad distribution of lifetimes ranging from <1 to >30 Myr. These results point to complex QSO light curves that exhibit structure on a wide range of timescales. By leveraging a new sample of FUV-bright QSOs selected from GALEX, SDSS, PanSTARRS and WISE, we request 32 orbits of HST/COS to double the number of QSOs to which we can apply this exciting new technique, which will allow us to make the first measurement of the distribution of QSO lifetimes.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Stellar Populations and the Interstellar Medium

ID: 16188

Program Title: Calibration of Scattered Light in STIS grating G230LB

Principal Investigator: Guy Worthey

PI Institution: Washington State University

This calibration proposal measures light scattered by the G230LB grating paired with the CCD detector on STIS. The improvement will have immediate impact on the fidelity of the Next Generation Spectral Library. The observational scheme is to observe three stars of differing temperature in two similar modes; CCD+G230LB and MAMA+G230L. Because the MAMA is mostly insensitive to red light, only the CCD spectra will show the scattered light problem. The scattered light will be modeled and applied to the NGSL.

In addition, the dependence of scattered light on the position of the star relative to the centerline of the slit at the time of exposure will be measured.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16302

Program Title: Accretion Rates as a Diagnostic Tool for the Origin of Planetary-mass Companions

Principal Investigator: Ya-Lin Wu

PI Institution: University of Texas at Austin

Direct imaging surveys have revealed a new population of substellar companions with masses around the deuterium burning limit and orbits often farther than 100 AU. The formation of these planetary-mass companions (PMCs) is not fully understood. While core/pebble accretion and dynamical scattering seem unlikely, disk fragmentation and prestellar core collapse remain to be tested. Simulations have shown that disk fragmentation generally leads to higher mass accretion rates than prestellar core collapse. Therefore, PMCs are expected to have higher accretion rates than free-floating planets/brown dwarfs if disk fragmentation is the dominant formation channel. Alternatively, if both populations have indistinguishable accretion rates, that would suggest a common origin. To test this prediction, we propose to observe the UV continuum excess and H-alpha emission for PMCs and free-floating objects with WFC3/UVIS multi-band imaging. Our targets are of comparable mass and age, and have evidence indicative of disks. We will carry out shock modeling and search for any population-level accretion rate differences between the two samples. We will also investigate the empirical relationship between H-alpha line luminosities and accretion luminosities from the stellar-mass toward the planetary-mass regime, in order to establish whether the mass assembly process for stars, brown dwarfs, and planetary-mass objects are analogous and continuous.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Exoplanets and Exoplanet Formation |
| ID: | 16204 |
| Program Title: | A New Method to Measure the Chemical Compositions of Extrasolar Planetesimals |


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| Principal Investigator: | Siyi Xu |
| PI Institution: | Gemini Observatory, Northern Operations |



The chemical composition of an extrasolar planet is a fundamental property with little observational signature. Spectroscopic observations of polluted white dwarfs have proven to be a successful pathway to constrain the compositions of disrupted planetesimals but this approach has its own limitations. Here, we propose a new method to measure the compositions of extrasolar planetesimals by observing the gas debris around polluted white dwarfs. These disks are fresh extrasolar planetary material in a transient stage, right after tidal disruption and before being completely accreted onto the white dwarf. Recent increases in the sample size of white dwarf gas disks combined with timely advancements in disk modeling efforts have made this new exploration feasible. This proposal will open a noval method to measure chemical compositions of extrasolar planetesimals.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Large Scale Structure of the Universe |
| ID: | 16250 |
| Program Title: | Refining the Mira Distance Scale and Hubble Constant for the Era of JWST and WFIRST |


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| Principal Investigator: | Wenlong | Yuan |
| PI Institution: | The Johns Hopkins University | |



Direct Hubble constant measurements rely on a solid extragalactic distance scale, which is conventionally calibrated with Cepheids and recently the tip of the red giant branch (TRGB). As a different approach, Mira variables exhibit promising properties as independent distance indicators. Miras are luminous in the NIR, follow tight period-luminosity relations (PLRs), and are present in all types of galaxies. Long-period Miras (400<P<1500 d) are much brighter and on steeper PLRs than the commonly used short-period Miras (100<P<400 d), and they would potentially add a new route to check the Hubble tension between the early and late Universe. For JWST and WFIRST they are easier to detect than Cepheids and reach further than the TRGB. We propose to (1) study the long-period Miras in the type Ia supernova host galaxy NGC 2525 and (2) refine the Mira-based Hubble constant with 4 Mira-SN calibrators. To do this we request four epochs of NIR imaging toward this face-on spiral galaxy. We will combine these observations with archival data to form a continuous time series with a 1300 d baseline, from which we will derive the period and mean intensity of long-period Miras in this system. We will calibrate the PLR for long-period Miras and develop them as a new longer-range distance indicator. For the second task we will measure the NIR colors in NGC 2525, NGC 1559, NGC 5643, and NGC 5861 in order to classify oxygen-rich Miras in these type Ia supernova hosts. The expanded Mira-SN calibrators and removal of carbon-rich Mira contamination will reduce the error in the current Mira-based Hubble constant by a factor of two.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | AR |
| Scientific Category: | Stellar Populations and the Interstellar Medium |
| ID: | 16160 |
| Program Title: | Far-ultraviolet insights into multiple populations in extragalactic globular clusters |


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| Principal Investigator: | Stephen | Zepf |
| PI Institution: | Michigan State University | |



Multiple populations are now known to be a ubiquitous feature of globular clusters in the Milky Way. This phenomenon has important implications for both star and cluster formation, but many questions remain. Integrated far-ultraviolet (FUV) observations allow us to extend the study of multiple populations to the larger and more diverse samples of extragalactic globular clusters. However, few clusters currently have these FUV data. This proposal will utilize archival ACS SBC F140LP observations of NGC 1399 to measure the FUV emission from a large sample of its globular clusters. Despite being taken over a decade ago, these data have never been used to study the galaxy's clusters. Given the potential to dramatically improve our understanding, with no new HST observing commitment, we propose to utilize this rich dataset. Furthermore, this analysis is timely in that it can guide future FUV observations of globular cluster systems under HST's "UV initiative".

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: GO

Scientific Category: Exoplanets and Exoplanet Formation

ID: 16319

Program Title: Probing mass loss from two mini-Neptunes orbiting a young solar analogue

Principal Investigator: Michael Zhang

PI Institution: California Institute of Technology

Photoevaporative mass loss is key to sculpting the properties of short period transiting exoplanets, yet current models have large theoretical uncertainties and relatively few observational constraints. In particular, mass loss has never been conclusively observed around mini Neptunes (2-3 $R_E$), even though this regime is crucial for understanding the bimodal radius distribution observed by \textit{Kepler}. The recently discovered transiting mini Neptunes TOI 1726.01 and 1726.02 are far and away the most promising targets for probing present-day mass loss. This pair orbits a nearby (22 pc) and young (400 Myr) solar analogue which is 50 times brighter than the Sun in X-rays, driving a strong outflow which should be detectable in Lyman alpha absorption.

We request 36 HST orbits to observe two UV transits of each planet with STIS/G140M. These observations will allow us to measure the size, shape, and kinematic structure of the exosphere, constrain the mass loss rate, and evaluate the magnitude of any visit-to-visit variability in the outflow structure. In addition, we will be able to test hydrodynamical models by comparing their predictions for the relative mass loss rates and exosphere geometries for the two planets to observations: a comparative approach that has hitherto been impossible.

Cycle 28 Abstract Catalog
(Based on Phase I Submissions)

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| Proposal Category: | GO |
| Scientific Category: | Solar System Astronomy |
| ID: | 16214 |
| Program Title: | Polarimetric Characterization of Oort Cloud Comet C/2017 K2 (PANSTARRS) Before Water Ice Sublimation |


| | |
|---|---|
| Principal Investigator: | Qicheng Zhang |
| PI Institution: | California Institute of Technology |



C/2017 K2 is intrinsically the brightest Oort cloud comet found in recent history, and presents a unique opportunity to efficiently characterize the constituent properties of a still primitive comet on its way in toward the inner solar system for the very first time. Its exceptional brightness in the outer solar system suggests it to be much larger than typical Oort cloud comets---normally too faint to observe at these distances---and makes it a particularly compelling target for early polarimetric characterization, which requires a high signal-to-noise ratio to usefully constrain its dust properties. Imaging polarimetry of nearby comets has previously revealed varied polarized structures, such as halos and jets, that reflect spatial variation in grain size and structure. Jets are of particular interest as they entrain and expose fresh grains from beneath the surface, previously shielded from the space environment since the formation of the solar system, and are too small/narrow to be resolved in the outer solar system by ground-based imaging polarimetry. We propose to use high resolution HST/ACS polarimetry and color imaging of C/2017 K2 at a pre-perihelion epoch 6.5--7 au from the Sun, well before the onset of water ice sublimation, to constrain the properties of refractory grains in the jets and surrounding coma, and their physical evolution as they move outward from the nucleus. These observations, in concert with analogous results from more evolved comets in the inner solar system, will probe the formation environments and evolutionary histories of these assorted comets, and their implications on the formation and evolution of the solar system as a whole.