

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14066

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14066  
Program Title: Hi-PEEC, Hubble imaging Probe of Extreme Environments and Clusters

Principal Investigator: Angela Adamo

PI Institution: Stockholm University

Starburst events play a major role in shaping the stellar content of galaxies at high redshift, due to the strongly enhanced gas fractions and merger rates in comparison to present-day galaxies. The fossils of those starburst episodes, the globular clusters (GCs), are outstanding witnesses to the dramatic changes that occurred in their host galaxies. To understand and interpret the rapid evolution occurring in starbursts at any redshift, we need to probe how the intensified duty cycle of gas consumption changes the nature of young massive cluster (YMC) populations. We therefore propose Hi-PEEC, an UV-optical study of YMCs in a uniquely accessible sample of 6 starbursts located in the nearby ( $D < 80$  Mpc) universe. Our targets have star formation rates higher than or comparable to the Antennae, and rich cluster populations. Monte Carlo simulations, including realistic assumptions of recent burst events and extinction gradients, prove our abilities to recover YMC properties (age, masses, extinction) inside the requested detection limits. We will be able to study the efficiency by which clusters form, the formation modes of the most massive clusters, their age and spatial distributions in mergers, as well as obtain insights into the recent star formation histories of the host galaxies. This proposal is aimed at unveiling the role of starburst environments in shaping the process of star and cluster formation. These studies will have important implications for our understanding of GC formation and will constitute a reference sample for future infrared-limited studies of the highly star-forming and heavily extinguished counterpart galaxies with the JWST.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14067

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14067  
Program Title: Searching for a Supermassive Black Hole in the Brightest Ultracompact Dwarf Galaxy

Principal Investigator: Chris Ahn

PI Institution: University of Utah

We request a single orbit of HST time to image the most luminous ultracompact dwarf galaxy (UCD), M59-UCD3, suspected to be the tidally stripped nucleus of a massive galaxy. We will combine these data with adaptive optics kinematic data from Gemini/NIFS to test for the presence of a supermassive black hole (SMBH) in this object. HST imaging will resolve the inner surface brightness profile of this very compact object, which is necessary creating dynamical models and in determining the PSF of the kinematic observations. Due to M59-UCD3's brightness, we expect to be able to detect the signature of any black hole above a few million solar masses; significantly smaller than the 21 million solar mass black hole recently found by our team in the slightly less luminous UCD, M60-UCD1. There is indirect evidence that supermassive black holes in UCDs, like the one in M60-UCD1, may represent a significant new population of supermassive black holes. M59-UCD3 provides an important test of this hypothesis.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14068

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14068  
Program Title: Resolving the Nuclear Regions of Confirmed Offset AGN

Principal Investigator: Robert Barrows

PI Institution: University of Colorado at Boulder

We propose HST observations of 10 SDSS galaxies that host X-ray detected active galactic nuclei (AGN) that are significantly spatially offset from the SDSS galaxy nucleus. Since the off-nuclear nature of an AGN can only result from a galaxy merger, these systems are confirmed mergers hosting AGN and give us the unique opportunity to study the connection between galaxy mergers and supermassive black hole (SMBH) growth. However, the resolution of the SDSS is insufficient to resolve the nuclear regions of these mergers, and the combined resolution, sensitivity and multi-band capabilities of HST are now necessary to utilize this sample for studies of galaxy and SMBH co-evolution. By also developing a carefully defined control sample from archival data, our proposed multi-band HST/WFC3 observations will permit us to measure the star-formation rates in the nuclear regions, facilitating a comparison between the triggering of AGN and star-formation in galaxy mergers and an investigation into the role mergers play in the co-evolution of galaxies and SMBHs. By resolving the stellar cores associated with the merging galaxies, we can determine the preference of major versus minor mergers in the triggering of AGN. This study can only be accomplished with HST because 1) the resolution of HST is necessary to resolve the nuclear regions of these merging systems; 2) the sensitivity of HST is necessary to detect the stellar cores if the merger is of a minor classification; and 3) the multi-band imaging is necessary to estimate star-formation rates.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14069

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14069  
Program Title: Searching For Multiple Populations in Massive Young and Intermediate Age Clusters

Principal Investigator: Nate Bastian

PI Institution: Liverpool John Moores Univeristy

We propose to obtain imaging of 12 massive clusters within the LMC/SMC, spanning a wide range of ages (100 Myr - 10 Gyr), in order to search for abundance spreads (i.e. multiple populations) within them. While all ancient globular clusters (GCs) studied to date, in the necessary detail, possess multiple populations, no massive ( $>10^5 M_{\text{sun}}$ ) young ( $< 1$  Gyr) or intermediate (1-8 Gyr) age clusters have been found with abundance spreads. This raises the fundamental question: what controls whether a cluster will host multiple populations? The standard suggestion is that cluster mass is the crucial parameter, although recent results on the initial masses of GCs have called this into question. An alternative view is that GC formation was fundamentally different than the formation of other ( $< 10$  Gyr) massive clusters. The proposed observations will definitively address whether age or mass is the crucial parameter controlling the appearance of multiple populations. The proposed sample occupies a critical region of parameter space (age/mass) where there are no Milky Way counterparts.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14070

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14070  
Program Title: A Red Supergiant Mass Accurate to 1%

Principal Investigator: Philip Bennett

PI Institution: Eureka Scientific Inc.

Red supergiants (RSGs) are massive, evolved stars that are among the brightest stars in the near infrared, and often serve as useful "standard candles" for extragalactic and cosmological studies. But this use of RSGs is hampered by the lack of fundamental mass and luminosity calibrations tying these objects to the theoretical H-R diagram. Theoretical evolutionary models are not very useful because of mass loss due to stellar winds in the RSG stage. Mass loss in RSG stars is not well understood, and is incorporated using various parameterizations. No accurate observationally-determined RSG masses are available. More than anywhere else in the H-R diagram, there is a pressing need for accurate stellar masses of red supergiants.

The determination of an accurate RSG mass is a priority. We propose to determine the mass of the K supergiant in the bright, well-studied, eclipsing binary system 31 Cygni (K4 Ib + B3 V). The orbital solution of the optically-dominant K supergiant has been accurately determined. Given this, a complete solution for both stellar masses can be found from a small number of radial velocity observations of the companion star. For 31 Cyg, archival STIS/E140H observations from 2001-02 (program GO-9109) are well-suited for this purpose. The orbital configuration of 31 Cyg in Cycle 23 is ideally separated by ~0.5 in phase from the archival observations (thereby maximizing the RV difference). We propose to obtain additional STIS/E140H observations in Cycle 23, and use these two sets of FUV observations to determine the mass of the 31 Cyg K supergiant to ~1%. These observations must be done soon, or the optimal phase window for doing so will be lost.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14071

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14071  
Program Title: How are HI Disks Fed? Probing Condensation at the Disk-Halo Interface

Principal Investigator: Sanchayeeta Borthakur

PI Institution: The Johns Hopkins University

Galaxy disks need a continuous supply of cold gas to fuel star formation. While accretion from the intergalactic medium brings in gas, this gas needs to condense down to a temperature  $<100\text{K}$  to form stars. Here, we propose to investigate the process of accretion and condensation of inflowing warm ionized gas into neutral atomic gas (HI) in the disks of galaxies and how this is affected by feedback from massive stars. To do so, we mount the first controlled absorption-line experiment to probe the interface between the disk and the circumgalactic medium (CGM). This study will complement the parameter space (in terms of impact parameter versus HI disk size) probed by the large HST program COS-GASS (PI:Heckman). Together these two programs will give us a continuous coverage of gas properties in galaxies from disks out to the virial radii. Our sample provides QSO-sightlines through 35 gas-rich galaxies ( $z= 0.003-0.05$ ) probing them at the disk-CGM interface. The proposed observations will probe a wide range of absorption-line transitions that will help us in identifying the underlying physics behind the process of condensation.

We will also use state-of-the art numerical simulations to interpret the observations in a physically motivated context, and provide constraints that test (and then improve) the simulations. We will generate synthetic spectra that will enable us to analyze the simulations in the exact same way as the proposed observations. Therefore, we will also be able to interpret our results in the context of physics of gas accretion and connect it to the global properties of the galaxies.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14072

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14072  
Program Title: The Evolution of Metal-rich Asymptotic Giant Branch Stars

Principal Investigator: Martha Boyer

PI Institution: NASA Goddard Space Flight Center

Theoretical models of Asymptotic Giant Branch (AGB) stellar evolution rely on observations of the ratio of carbon-rich (C) to oxygen-rich (M) stars and the carbon star luminosity function (CSLF). Sensitivity and resolution limitations have restricted measurements of C/M and the CSLF to metal-poor environments in nearby galaxies. Unfortunately, while HST WFC3/IR broad-band imaging can detect AGB stars in more distant, metal-rich galaxies, it is impossible to distinguish between different AGB subtypes with only the available broad-band filters. However, our successful Cycle 20 1-orbit pilot program showed that AGB stars can be effectively separated into C and M stars using the WFC3/IR medium-band filters. Thus, detailed studies of AGB stellar evolution are now possible in galaxies that are only resolvable with HST. We propose to use the WFC3/IR medium-band filters to make the very first bias-free measurement of C/M and the CSLF in a metal-rich environment (M31). Our high-precision measurement of the morphology of the CSLF will calibrate the efficiency of the third dredge up and the minimum core mass to form a C star, both of which depend on the metallicity. Our measurements of the C/M ratio will leverage M31's metallicity distribution to determine the metallicity limit above which C stars cannot form. The interpretation of these observations is straightforward owing to the ability to leverage data products from the Panchromatic Andromeda Treasury (PHAT) program. As a result, we can conclusively evaluate AGB evolution models in a never-before-tested, metal-rich environment.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14073

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14073  
Program Title: Assessing the Impact of Metallicity on Stellar Dust Production

Principal Investigator: Martha Boyer

PI Institution: NASA Goddard Space Flight Center

Asymptotic Giant Branch (AGB) stars may be a dominant source of dust in the Universe, but it is unknown how low metal abundances affect the efficiency of AGB dust production. The role of AGB dust at early times is therefore unclear (e.g., in high-redshift quasars). Stellar evolution and dust models for AGB stars are highly uncertain primarily because they are calibrated only at a few metallicities. As a result, models conflict about the strength of dust production in metal-poor stars even when the stars are capable of producing their own condensable material. Using infrared imaging of dwarf galaxies with Spitzer, we have recently detected the first examples of dusty (optically obscured) AGB stars at metallicities more than an order of magnitude lower than previously observed. However, we cannot characterize the spectral types (and thus the dust species) or the total rate of dust production without additional data in the near-infrared. We propose to image these galaxies using the medium-band WFC3/IR filters, which can efficiently separate carbon- and oxygen-rich AGB stars. In addition, cycle 23 observations will be contemporaneous with new Spitzer observations, providing near-simultaneous spectral coverage from 1-5 microns of these large-amplitude stars. Armed with the spectral types and complete spectral coverage from the proposed observations, we will obtain accurate dust-production rates for >100 stars spanning 0.7%-8% solar metallicity. These will be the first measurements of their kind at such low metallicities, and they will calibrate models of AGB evolution and of galaxy dust evolution in metal-poor environments that are representative of high-redshift galaxies.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14074

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14074  
Program Title: Opening the Window on Galaxy Assembly: Ages and Structural Parameters of Globular Clusters Towards the Galactic Bulge  
Principal Investigator: Roger Cohen  
PI Institution: Universidad de Concepcion

The primary aim of this program is to undertake a systematic investigation of highly reddened Galactic globular clusters (GGCs) located towards the Galactic bulge. These clusters have been excluded from deep space-based photometric surveys due to their severe total and differential extinction. We will exploit the photometric depth and homogeneity of two existing Treasury programs (the ACS GGC Treasury Survey and the WFC3 Bulge Treasury Program) along with the unique optical+IR parallel imaging capabilities of HST to finally place the bulge GGCs in the context of their optically well-studied counterparts. Specifically, by leveraging ACS/WFC together with WFC3/IR, we first exploit the reddening sensitivity at optical wavelengths to map severe, small-scale differential reddening in the cluster cores. Corrected two-color WFC3/IR photometry will then be used to measure cluster ages to better than 1 Gyr relative precision, finally completing the age-metallicity relation of the Milky Way GGC system. Ages are obtained using a demonstrated procedure which is strictly differential, and therefore insensitive to total distance, reddening, reddening law, or photometric calibration uncertainties. At the same time, deep archival Treasury survey imaging of the Galactic bulge will be used to decontaminate cluster luminosity functions, yielding measurements of bulge GGC mass functions and mass segregation on par with results from the ACS GGC Treasury survey. Finally, the imaging which we propose will be combined with existing wide-field near-IR PSF photometry, yielding complete radial number density profiles, structural and morphological parameters.

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**Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)**

14075

**Proposal Category:** GO  
**Scientific Category:** Hot Stars  
**ID:** 14075  
**Program Title:** Long-Lost Companions: A Search for the Binary Secondaries of Three Nearby Supernovae

**Principal Investigator:** Ori Fox  
**PI Institution:** University of California - Berkeley

Stripped-envelope supernovae (e.g., SNe IIb, Ib, and Ic) refer to a subset of core-collapse explosions with progenitors that have lost some fraction of their outer hydrogen and helium envelopes in pre-SN mass loss. Mounting evidence over the past decade suggests that the mass loss in a large fraction of these systems occurs due to binary interaction. An unbiased sample of companion-star characteristics (including deep upper limits) can constrain the binary models, but to date only two results have been published: SNe 1993J and 2011dh. In this proposal, we present 2 new archival discoveries and a plan to perform a WFC3/NUV search for the binary companion stars of 3 additional, nearby stripped-envelope SN progenitors: SNe 2002ap, 2001ig, and 2010br. The NUV color (F275W-F336W) offers an optimum detection strategy for the potential hot, blue stars. The combined dataset will result in a statistically meaningful sample of companion stars, with direct implications on the theoretical physics of binary interaction. Such a project cannot wait for more nearby SNe. Only 15 stripped-envelope SNe have occurred within our calculated sensitivity window (<15 Mpc) within the past 25 years, and of those, only 6 were at <10 Mpc. Given HST's time horizon (currently 2018), 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.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14076

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14076  
Program Title: An HST legacy ultraviolet spectroscopic survey of the 13pc white dwarf sample

Principal Investigator: Boris Gaensicke

PI Institution: The University of Warwick

Over 95% of all stars in the Galaxy will become white dwarfs, and this dominant population of stellar remnants plays a unique and central role for our understanding of the formation and evolution of stars, planetary systems, and the Galaxy itself. White dwarfs are fundamental for many areas of astrophysics, including post main-sequence mass loss, the local star formation history, the bulk composition of extra-solar planets, and the characterisation of dark energy.

Despite their fundamental importance for a wide range of astrophysical problems, our knowledge of the galactic white dwarf population is remarkably fragmentary: the only volume-limited and unbiased sample of white dwarfs contains 43 stars within  $d < 13$  pc (of the Sun). This sample is dominated by cool and old stars, and an accurate determination of their temperatures, masses, and ages requires a detailed understanding of plasmas and convection at fluid-like densities.

Our team has carried out substantial theoretical and computational work on improved model atmospheres and all relevant input physics. The strongest effect of our new calculations on the emergent flux occurs at ultraviolet wavelengths, and we propose to obtain STIS and COS spectroscopy for all white dwarfs in the volume-limited 13pc sample to (1) test and calibrate our atmosphere models, which we will eventually apply to the  $\sim 200000$  WDs discovered by Gaia, (2) turn the 13pc sample into the most accurate cosmic clocks reconstructing the local star formation history, and (3) probe in an unbiased way the frequency of rocky planet formation in the early ages of the Galaxy.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14077

Proposal Category: SNAP  
Scientific Category: Extra-Solar Planets  
ID: 14077  
Program Title: The frequency and chemical composition of rocky planetary debris around young white dwarfs: Plugging the last gaps  
Principal Investigator: Boris Gaensicke  
PI Institution: The University of Warwick

Many planetary systems will survive the post main-sequence evolution of their host stars into white dwarfs (WDs). In the solar system, Mars, the asteroid belt, and the outer planets will eventually orbit the WD remnant of the Sun, and many WDs are known to have remnants of planetary systems. Historically, planetary debris was detected in ~20% of WDs with cooling ages >0.5Gyr from Ca K detections. However, the Ca II ionisation balance makes the ground-based detection of planetary debris at younger, hotter WDs impossible.

We have carried out a very successful Cycle 18/19 COS snapshot survey of 100 WDs with cooling ages of 20-200Myr, and detect metal pollution in up to 50% of all targets via the strong Si resonance lines. This survey also showed that terrestrial material is common around A-stars, that rocky exo-planetary bodies display a similar variety in abundances as the meteorites in our solar system, and that water-rich Ceres-like asteroids still exist in evolved planetary systems.

We were approved a Cycle 22 COS snapshot program to close the last gaps in the statistics of evolved planetary systems, i.e. an extension of our snapshot survey to cooling ages of 5-25Myr and 100-300Myr. Our orbital integrations suggest that mass-loss during the AGB phase can stir up instabilities leading to planet-planet collisions, which should be most frequent during the first 10Myr, and these observations will unambiguously test these predictions. However, due to the limit on the total number of approved COS snapshots our target list was reduced by 35%, and we apply here for a Cycle 23 extension of the survey to reach the same statistical significance as our Cycle 18/19 programs.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14078

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14078  
Program Title: New Faint Galaxies at the Local Group's Edge: Antlia B and Five Candidate Ultra-Faint Dwarfs

Principal Investigator: Jonathan Hargis  
PI Institution: Haverford College

We propose to use six orbits with HST/ACS to obtain follow-up optical imaging of a newly-discovered Local Group dwarf galaxy (Antlia B;  $M_V = -9$ ,  $d \sim 1.3$  Mpc) and five candidate ultra-faint dwarf galaxies -- all of which may be satellites of the nearby dwarf irregular galaxy NGC 3109 ( $M_V = -14.9$ ,  $d=1.3$  Mpc). This may be the first system of satellites observed around a dwarf galaxy in isolation, and the first ultra-faint dwarfs observed in a sub-Milky Way environment. We will use the resolved stellar populations of these objects to (i) obtain a detailed star formation history and improved distance measurement for Antlia B, (ii) resolve the ultra-faint dwarf candidates into stars to confirm their discoveries, and (iii) place meaningful constraints on the presence of young stellar populations in the new ultra-faints. Our discovery data for Antlia B reveals evidence for a population of young stars; Our proposed observations will provide the needed photometric depth and precision to quantify the extent of Antlia B's young stellar population. The confirmation of any new ultra-faint dwarfs will deliver the first such objects in a low density environment. Their presence (or absence) of recent star formation will provide a critical benchmark for improving our understanding the impact of environment on ultra-faint dwarf galaxies; All currently known ultra-faint dwarfs are associated with massive galaxies (e.g. Milky Way, M31) and display little to no star formation in the last 10 Gyr.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14079

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14079  
Program Title: Unveiling the Dark Baryons II: the First Sample of OVI Emission Imaging

Principal Investigator: Matthew Hayes

PI Institution: Stockholm University

Hot gas outflows, crossing the extended circumgalactic medium of galaxies, regulate star formation, shape the galaxy luminosity function and mass-metallicity relation, and enrich the intergalactic medium. Over a wide temperature range of  $5 < \log(T/K) < 6$ , the cooling of this hot CGM flow is dominated by OVI ( $\lambda = 1032, 1038$  AA) emission. Thus OVI plays a vital role in driving, cooling, and observationally probing galaxy outflows. The difficulty is that OVI gas is typically only seen in absorption against QSOs: spatial information for a single galaxy has therefore never been available, making it difficult to estimate the mass of missing baryons/metals in this phase and its impact on braking galaxy superwinds and enriching the IGM.

We have devised a method of using ACS/SBC to isolate far UV emission lines, demonstrated it many times on Lyman alpha, and in HST Cycle 22 adapted to OVI. For the first time we have mapped OVI emission, revealing the halo of extended emission. We here propose to produce the first set of such images, extending the sample to a total of five galaxies, by targeting four more strong starbursts at  $\langle z \rangle = 0.25$ . From calibrated OVI maps we will calculate the allowed ranges of temperature, metallicity, and density, and estimate the OVI mass from resolved information. New constraints on galactic wind models and input for cosmological simulations may be expected.

This work is exploratory, but the possible scientific return is extremely high, and the method verified. Results will guide subsequent HST observations and next generation UV satellites, and thus it is truly in the spirit of the UV initiative.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14080

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14080  
Program Title: LyC, Ly-alpha, and Low Ions in Green Peas: Diagnostics of Optical Depth, Geometry, and Outflows  
  
Principal Investigator: Anne Jaskot  
  
PI Institution: Smith College

The "Green Peas" are extreme, low-redshift starbursts that are under intense scrutiny as a possible class of Lyman continuum (LyC) emitting galaxies. Their extreme [O III]/[O II] ratios resemble those of  $z>2$  Ly-alpha emitters (LAEs) and suggest conditions conducive to high LyC escape fractions. Our initial COS study of four extreme GPs demonstrated the diagnostic power of Ly-alpha emission plus low-ionization absorption and emission lines to simultaneously relate optical depth, neutral gas geometry, and Ly-alpha radiative transfer. We now propose to test this understanding by confirming these relationships and trends: we will combine these data with new COS spectra of 13 of the most extreme GPs, extending our analysis to a statistically significant sample. One of the targets has the highest [O III]/[O II] ratio in the entire SDSS survey. The combined 17 total spectra of these rare, highly ionized starbursts will provide the first statistics on optical depth and Ly-alpha emission within this key, extraordinary galaxy population. The proposed COS observations will confirm whether galaxies with extreme [O III]/[O II] are indeed often optically thin and will likely lead to revealing the Ly-alpha profiles characteristic of LyC-emitting galaxies. By linking optical depth, outflow geometry, and Ly-alpha profiles, these observations will provide a vital basis for interpreting high-redshift LAE spectra.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14081

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14081  
Program Title: Probing Supernovae Chemical Yields in Low Metallicity Environments with UV Spectroscopy of Magellanic Cloud B-type Stars  
Principal Investigator: Thierry Lanz  
PI Institution: Observatoire de la Cote d'Azur

Spectrum synthesis studies of the UV spectra of sharp-lined main sequence B stars provide astronomers with some of the best determinations of the abundances of the light, Fe group, and neutron capture elements. B stars are therefore best-suited to study the chemical evolution of the Magellanic Clouds. But the HST archive is virtually devoid of high resolution spectra of such objects. We propose FUV and NUV observations with the COS G130M, G160M, G185M, and G225M gratings. The four program stars have been observed with the FUSE spacecraft, hence this project will produce continuous high-resolution spectral coverage from 950 to 2400 Å and provide a permanent archive of fundamental spectra from which ground-breaking studies of the Magellanic Clouds can be performed in the decades to come. This limited program aims at producing an extragalactic, low-metallicity counterpart to the bright star library of early B stars that is currently being obtained as part of the HST Cycle 21 Treasury program "Advanced Spectral Library II: Hot Stars" (GO 13346, PI T. Ayres).

Spectral lines from most Fe group and s-process elements are found only in the UV region in B stars and information on their abundances is important for studying the chemical evolution of a galaxy, computing opacities for stellar evolution calculations, and assessing the validity of theoretical calculations of explosive nucleosynthesis. Comparing the derived abundances of iron-peak and heavier elements in galactic and Magellanic Cloud B main sequence stars will provide an empirical probe of chemical yields ejected by evolved stars and supernovae in different environments.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14082

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14082  
Program Title: Connecting white dwarf rotation and debris accretion

Principal Investigator: Dan Maoz

PI Institution: Tel Aviv University - Wise Observatory

Recent Kepler photometry has revealed that half of white dwarfs have periodic, low-level ( $\sim 10^{-3}$ - $10^{-4}$ ), optical variations. HST UV spectroscopy has shown that half of white dwarfs are actively accreting rocky planetary debris. By obtaining UV spectra of 10 WDs monitored with Kepler, we will test the hypothesis that these two phenomena are causally connected, i.e. that the optical periodic modulation is caused by WD rotation coupled with an inhomogeneous surface distribution of accreted metals. If there is a match between the periodically variable WDs and the WDs with UV line opacity, this will confirm the hypothesis. The Kepler photometric modulation will then be established as the first method that can provide reliable rotation periods for hundreds of normal WDs. WD rotation is a critical observable for understanding stellar evolution, stellar mass loss, Type-Ia supernova progenitors and more, but rotation periods have been measured for only tens of WDs, mainly rare magnetic ones. Furthermore, confirmation of the connection between UV line opacity and optical modulation will provide an inexpensive photometric probe for identifying accretion of rocky debris in large samples of WDs, and mapping its dependence on WD (and progenitor system) properties. If the hypothesis is rejected (there is no match between UV line opacity and optical modulation), this will point to alternative and no-less-interesting explanations for the optical variability, e.g. the abundant presence of close-in companions to WDs, such as giant planets or secondary cool WDs.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14083

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14083  
Program Title: The nature and environment of the most luminous starburst galaxies at redshift  $> 5$

Principal Investigator: Ismael Perez-Fournon

PI Institution: Instituto de Astrofisica de Canarias

We propose HST WFC3 imaging of the brightest three recently discovered, dusty star forming galaxies at  $z > 5$ , selected from the Herschel HerMES survey and with CO redshifts measured with ALMA in a cycle 2 program. Theoretically, the existence of dusty, massive starbursts at such early epochs is difficult to explain and thorough observational constraints on their properties provides a stringent test of galaxy formation models. Our targets have a multitude of far-infrared follow-up data, including SMA and NOEMA observations and the CO spectroscopy in the 3mm ALMA band that revealed their extreme redshifts. However, the currently available ground-based, near-IR observations are shallow and lack the resolution and sensitivity of HST at these wavelengths, which is needed to completely reveal these rare galaxies, and to measure any gravitational lensing amplification. We will use the proposed data to measure the physical properties of these three  $z > 5$  dusty starbursts, including their sizes, stellar masses, and the scale and intensity of the star formation. There is also evidence of gravitational lensing and the HST data are crucial for accurately measuring the lensing amplification and reconstructing the source plane. The wider field data will be used to investigate the environments of these galaxies and determine whether they are protocluster members, as often expected of massive high-redshift galaxies and similarly to some other  $z \sim 4 - 5$  starbursts. We will be able to measure the dark matter halo mass scale and thereby consider the evolution and descent of these galaxies, particularly in comparison with lower redshift dusty starbursts.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14084

Proposal Category: GO  
Scientific Category: ISM and Circumstellar Matter  
ID: 14084  
Program Title: Connecting Earth with its Galactic Environment: Probing Our Interstellar Past Along the Historical Solar Trajectory  
Principal Investigator: Seth Redfield  
PI Institution: Wesleyan University

We propose to observe a sample of stars along the historical solar trajectory to probe the physical properties of our past interstellar environments. For more than 90 years there has been speculation surrounding the relationship between the interstellar medium, its influence on our heliosphere, and ultimately on variations in the atmosphere and even organism evolution here on Earth. By looking locally, at our most recent interstellar history, we can minimize many of the complications that have made establishing such a relationship difficult. The low column densities require high resolution spectroscopy of the strongest resonance lines, which are in the UV. This program will complement a ground-based survey that utilized the two strongest transitions in the optical, CaII and NaI, but was unable to detect the lowest interstellar column densities within 100 pc. Therefore, this is necessarily a UV program and the strength of UV transitions will ensure detection of this material. The observations will be used to measure the number of clouds, their distances, densities, and velocities along this special line of sight. These measurements will be used to reconstruct the recent variations in heliospheric structure and Galactic cosmic ray flux as a result of passing through these clouds. Our observational results can be compared with existing geological tracers of cosmic rays. If these observations support a relationship between our past interstellar surroundings and the cosmic ray flux at 1 AU, it would have important implications for the history of the Earth's biosphere, as well as a new context to evaluate the interstellar environments of nearby stars with planetary systems.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14085

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14085  
Program Title: Circumgalactic gas at its extreme - the absorption properties of interacting galaxies

Principal Investigator: Philipp Richter

PI Institution: Universitat Potsdam

We propose HST/COS observations of two background QSOs whose sightlines pass through the extended tidal gas filaments of the interacting galaxy NGC4631 at impact parameters of 40 and 80 kpc. The "whale galaxy" NGC4631 represents one of the most spectacular and best-studied example of a gas-rich interacting galaxy at  $z \sim 0$ . We recently obtained extremely deep HI 21-cm observations as part of the HALOGAS project and identified two QSOs that can be used to trace the same physical region in absorption. We will combine the UV absorption-line data from COS (covering important low and intermediate ions such as OI, SiII, SiIII) with the new 21-cm data from HALOGAS. The goal is to study the kinematics and chemical composition of the circumgalactic gas component of NGC4631 and to explore its origin and fate. We further want to characterize the absorption properties of the NGC4631 environment in the general context of quasar-absorption line systems and estimate the contribution of interacting galaxies to the cross section of intervening Lymanlimit systems and Damped-Lyman-Alpha absorbers. Only HST/COS provides the necessary UV capabilities to combine these important aspects of galaxy evolution and QSO absorption-line statistics in the local universe.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14086

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14086  
Program Title: Dynamical Confirmation of a Stellar-mass Black Hole in the Globular Cluster M62

Principal Investigator: Jay Strader

PI Institution: Michigan State University

Using radio, X-ray, and optical observations, we have discovered the first candidate black holes in Milky Way globular clusters. The existence of stellar-mass black holes in globular clusters would have broad implications: (a) globular clusters would become important hunting grounds for stellar-mass black holes, of which few are still known; (b) black holes in globular clusters would offer good tests of the physics of low-luminosity accretion; (c) globular clusters might offer a less biased view of the black hole mass function than the field; and (d) the prospects for detecting gravitational wave sources such as black hole--black hole binaries would be improved. The black hole candidate in the Milky Way globular cluster M62 is the first with a bright red giant secondary. We propose multi-epoch STIS spectroscopy of this star to obtain the first dynamical confirmation of a black hole in a globular cluster.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14087

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14087  
Program Title: Identify the signature of neutron star mergers through rapid Hubble observations of a short GRB  
  
Principal Investigator: Eleonora Troja  
  
PI Institution: University of Maryland

The afterglow of some short GRBs displays a late-time rebrightening, visible a few days after the gamma-ray burst. Recent HST observations provided tantalizing evidence that such late-time bump could be explained as the emergence of the underlying kilonova emission. This would represent the incontrovertible signature of a neutron star merger, and the first direct link between short GRBs and their progenitors. If the kilonova interpretation is correct, it would also confirm that neutron star mergers are significant and possibly dominant sources of the heaviest elements (e.g. gold, platinum, uranium) in the Universe.

Here we ask for rapid HST follow-up observation of a nearby ( $z < 0.4$ ) short duration GRB in order to detect the expected kilonova bump, and to constrain the origin of the observed emission. Multi-color observations are critical to pin down the nature of the observed rebrightening, and to distinguish it from the standard afterglow. The proposed observations will provide the smoking gun evidence connecting short GRBs and neutron star mergers, and will serve as a powerful observational input in the forthcoming era of gravitational wave astronomy.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14088

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14088  
Program Title: Unveiling the Lyman continuum morphology with HST

Principal Investigator: Eros Vanzella

PI Institution: INAF, Osservatorio Astronomico di Bologna

One of the key questions in observational cosmology is the identification of the sources responsible for cosmic reionization and for keeping the IGM ionized at all times. The general consensus is that a population of faint low-mass galaxies must be responsible for the bulk of the ionizing photons. However, attempts at identifying the ionizing Lyman continuum radiation (LyC) leaking from the individual galaxies have so far been largely unsuccessful at any redshift. What controls the escape of ionizing radiation from star-forming galaxies? And at which level? We propose here to observe the LyC domain of the only two known galaxies, one at  $z=3.213$  and the other at  $z=3.795$ , for which a leakage of ionizing radiation has already been detected, while other observed properties (UV and near-infrared spectra) are also consistent with a high LyC escape fraction. Goal of the observations is to determine where the ionizing radiation is escaping from the galaxies, i.e. the central regions or the periphery, and whether the emission is diffuse, patchy or unresolved. This will help identify the conditions that allow ionizing photons to leave the galaxies and to identify possible links with other properties of these galaxies. Only HST has the angular resolution to allow imaging of the LyC emission at the sub-kpc scales and characterize its spatial distribution relative to the non-ionizing UV emission (from existing GOODS+CANDELS images), as well as other wavelengths. This project is currently the unique concrete possibility to conduct a direct empirical investigation of the physical conditions regulating the escaping ionizing radiation.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14089

Proposal Category: GO  
Scientific Category: Debris Disks  
ID: 14089  
Program Title: Far-UV observations of H, C, N and O in exocomets of Beta Pic

Principal Investigator: Paul Wilson

PI Institution: CNRS, Institut d'Astrophysique de Paris

The Beta Pictoris system is a young planetary system embedded in a debris disk that is continually replenished by the collision and evaporation of planetesimals and exocomets. As a result of the edge-on inclination of the debris disk, the gas component of the disk and transiting exocomets can be observed in great detail using absorption spectroscopy. In February 2014, our COS observations yielded the first detection of exocomets in the far-UV. Several new exocometary species were detected for the first time including HI, CII, NI, OI and all the ionization states of Si. The measured radial velocities of these two exocomets are consistent with the two dynamically different exocomet populations known to exist in the Beta Pictoris system. We propose to determine the abundance of key species in a larger sample of exocomets and test the hypothesis that the two dynamically different exocomet populations have different compositions. This can be achieved by the acquisition of several spectra at different epochs. This will allow us to better distinguish the signatures of the interstellar medium, the gas disk and the transiting exocomets. Measuring the abundance of the key species H, C, N and O in a larger sample of evaporating exocomets will enable us to trace the condensation and evaporation processes present in the late stages of planetary formation. Notably, such abundance measurements are only possible via far-UV observations. These measurements will provide insight into the origins of the exocomets of the Beta Pictoris system.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14090

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14090  
Program Title: New FUV diagnostics of the atmosphere of the hot-Jupiter HD 209458b with HST/COS  
Principal Investigator: Gilda Ballester  
PI Institution: University of Arizona

As the first known transiting exoplanet, HD 209458b has set various precedents in the study of the lower and upper atmospheres of worlds beyond our solar system. The discovery with HST STIS/G140L FUV transit observations of this hot Jupiter of an extended upper atmosphere of H I and heavy O I and C II species has driven much theoretical work to explain the heating and inflation at high altitudes caused by the large XUV input from the nearby star. Our recent work shows however that the stellar activity and XUV input have been significantly overestimated in all previous studies. With up-to-date upper-atmosphere models combined with magnetospheric simulations, we find that for the STIS results of line-integrated absorptions of about 10%, the extended distributions of O I and C II should be accompanied by broad line-absorption profiles from non-thermal processes together with supersolar abundances in O and C, and the planet may also possess an extended magnetosphere. The picture is degenerate, but can be significantly improved if detections better than the 2-3 sigma measurements from STIS are obtained. The unique FUV capabilities of HST COS/G130M will be exploited for this key target. Line-integrated absorptions in both O I and C II will be measured at ~ 5 -10 sigma. For the first time, absorption line profiles will be adequately resolved, with information on Doppler shifts and equivalent widths to help distinguish between atmospheric scenarios and potential magnetospheric phenomena.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14091

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14091  
Program Title: Bulge structure and kinematics in an extreme spiral galaxy hosting megaparsec-scale radio jets  
  
Principal Investigator: Aaron Barth  
  
PI Institution: University of California - Irvine

The radio galaxy 2MASX J23453268-0449256 is an extreme object with unprecedented properties. It is a disk-dominated and unusually massive red spiral with a rotation speed of 430 km/s at  $r=15$  kpc, and its Mpc-scale radio jets are the largest ever found emerging from a spiral host. Ground-based imaging suggests that its central component is a pseudobulge, and its central stellar velocity dispersion is 350 km/s, surprisingly high for a disk-dominated spiral. X-ray observations show indications of radio-mode feedback on the hot gaseous halo on scales of tens of kpc, also extremely unusual for a spiral galaxy environment. This object challenges the conventional wisdom that the hosts of large-scale radio jets are exclusively early-type galaxies. We propose to obtain new WFC3 optical and IR imaging and Gemini GMOS-IFU spectroscopy of J2345. With the new HST imaging, we will carry out definitive bulge/disk decompositions and quantify the bulge structural parameters accurately, essential for understanding the environment of the central black hole powering the radio jets. GMOS IFU data will provide high-quality spatially resolved measurements of the stellar and gas kinematics of the bulge, which will be used to model the mass distribution in this unique system. Together, these observations will enable us to accurately quantify the structure and kinematics of this extreme galaxy and clarify its physical properties and formation history.

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**Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)**

**14092**

**Proposal Category:** GO  
**Scientific Category:** Solar System  
**ID:** 14092  
**Program Title:** Collisional Processing in the Kuiper Belt and Long-Range KBO Observations by New Horizons  
**Principal Investigator:** Susan Benecchi  
**PI Institution:** Planetary Science Institute

The dynamically quiescent, Cold Classical, part of the Kuiper Belt is distinctive in the color and binary properties of the objects within it. As such it is thought to host some of the most primordial objects in the solar system. Observations of the smallest objects in this population provide an opportunity to probe the small end of the size distribution with respect to how much collisional processing has played a roll in their evolution. Fortuitously the New Horizons (NH) spacecraft will fly through this part of the Kuiper Belt after its encounter with the Pluto system providing the opportunity for observing as many as 10 objects from long range. Unfortunately, the NH observations will be panchromatic. We propose to obtain colors and to search for binary companions to 7 of these objects and the NH encounter Kuiper Belt object (KBO; 2 were observed with HST in previous cycles), so that we can link the single filter, and higher resolution, spacecraft data from the distant targets to the color and binary data available in the literature. This is key for a full interpretation of both datasets and, with reasonable extrapolations, in application to the larger KBO population. The observations are timely because identification of a binary system before observation by the NH spacecraft can influence the observations to be carried out at each target and help to prioritize the targets should it not be possible due to timing or fuel constraints to observe all of them.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14093

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14093  
Program Title: Stellar Populations and Physical Conditions at ~100 pc Resolution in a Lensed Galaxy at  $z \sim 4$   
Principal Investigator: Danielle Berg  
PI Institution: University of Wisconsin - Milwaukee

Large surveys of star-forming galaxies at high redshift ( $z > 1.5$ ) have provided us with a broad understanding of how galaxies assemble and evolve, but the spatial and spectral limitations inherent in observing faint, distant objects mean that many of the physical processes regulating this dynamic evolution are poorly constrained. Much of our most detailed knowledge of the physical conditions in distant galaxies comes from careful studies of gravitationally lensed sources, few of which are at  $z > 3.5$ . FOR J0332-3557 is a gravitationally lensed galaxy at  $z \sim 4$  for which we and other groups have obtained a total of 37.3 hours of VLT spectroscopy. The rest-frame UV spectrum is notable for its unusual combination of both strong emission lines in the rest-frame UV and strong Ly $\alpha$  and interstellar absorption, and for the unusual spatial variation seen in the nebular emission lines, which are less extended than the underlying stellar continuum. We propose high spatial resolution imaging of FOR J0332-3557 with four broadband filters on WFC3, taking advantage of both the HST resolution and the lensing magnification to study star formation and extinction on ~100 pc scales. Because the interpretation of our unusual rest-frame UV and optical spectra requires an accurate reddening estimate, combining these observations with ground-based spectroscopy will give the most complete picture to date of chemical evolution in a distant galaxy.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14094

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14094  
Program Title: Characterization of the extended atmosphere and the nature of the hot super-Earth 55 Cnc e and the warm Jupiter 55 Cnc b  
Principal Investigator: Vincent Bourrier  
PI Institution: Observatoire de Geneve

The super-Earth 55 Cnc e transits an extremely bright star ( $V=6$ ) at a very short separation ( $a=0.016$  au). The mean density of this planet suggests it is surrounded by a thick gaseous envelope, yet our observations at Lyman-alpha detected no significant amounts of hydrogen or water. Located within a carbon-rich system, 55 Cnc e might be a 'Super-Venus' with a carbon-dioxide envelop containing metals such as Mg. We propose to further constrain the nature of this planet through COS observations in the CII line, to assess the presence of an extended cloud rich in ionized carbon produced by the photodissociation of the irradiated CO<sub>2</sub> envelope. We will further characterize the structure of this cloud through observations in the Mgi line, recently revealed as a sensitive probe of extended atmospheres. We estimate that signatures of escaping magnesium atoms could be detected with STIS with high S/N > 13. We also detected significant Ly-alpha absorption at the inferior conjunction of the warm giant 55 Cnc b, suggesting that we witnessed the partial transit of an extended hydrogen envelope around a non-transiting planet grazing the star. The planet lies beyond 0.1 au and is thus in a lower regime of irradiation than hot Jupiters. We propose to use the CII line to confirm the presence of an extended atmosphere around 55 Cnc b, and to investigate its regime of evaporation. We will observe simultaneously the atmospheric transits of 55 Cnc e and b in the CII line using the same COS visit. Both STIS and COS proposed spectral ranges will allow us to look for many additional species in the upper atmospheres of these two planets, in completely different regimes of mass and irradiation.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14095

Proposal Category: SNAP  
Scientific Category: ISM in External Galaxies  
ID: 14095  
Program Title: Calibrating the Dusty Cosmos: Extinction Maps of Nearby Galaxies

Principal Investigator: Gabriel Brammer

PI Institution: Space Telescope Science Institute - ESA

We propose to carry out a WFC3 snapshot survey of nearby galaxies to obtain high spatial resolution dust extinction maps by imaging the galaxies in the H-alpha and Paschen-beta narrowband filters. Our sample comprises 53 local infrared-luminous galaxies from the GOALS survey and is supplemented with 64 additional galaxies with existing archival H-alpha imaging. Extinction maps derived for the LIRGs, in particular, offer an exciting avenue into understanding the dust and extinction geometry in gas-rich, dusty galaxies that are observed in large numbers and even dominate the massive galaxy population at  $z \gg 1$ . Reaching spatial scales of just 30 pc per pixel, we will also begin to probe the sub-grid scales of even the latest generation of hydrodynamical simulations and observationally bridge the gap toward analytical treatments of simplified geometries of individual clouds.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14096

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14096  
Program Title: RELICS: Reionization Lensing Cluster Survey

Principal Investigator: Dan Coe

PI Institution: Space Telescope Science Institute - ESA

Hubble's WFC3 has revealed  $\sim 2,000$   $z \sim 6-11$  candidates in the universe's first billion years, but only a small fraction have been bright enough ( $H < 25.5$ ) for detailed follow-up study and spectroscopic confirmation. The highest redshift searches ( $z \sim 9-12$ ) have yielded fewer candidates than expected, leaving luminosity functions highly uncertain while hinting at accelerated evolution in the first 600 Myr. We propose a more efficient search for brightly observed high-redshift galaxies by targeting 46 fields exceptionally lensed by 41 galaxy clusters lacking HST infrared imaging. By leveraging the Planck SZ galaxy cluster catalog and archival ACS imaging, we will efficiently deliver over 100  $z \sim 9-12$  candidates placing strong new constraints on luminosity functions with minimal cosmic variance uncertainty. RELICS will also deliver  $\sim 170$   $z \sim 8$  candidates including  $\sim 20$  brighter than  $H < 25.5$ . Follow-up spectroscopy will confirm  $z > 8$  with Ly $\alpha$ , constrain the patchy nature of reionization, and detect redder UV spectral lines such as CIII]1909A. ALMA follow-up will reveal dusty evolved populations in the early universe. Joint lensing + X-ray + SZ analyses will improve currently uncertain mass scaling relations and tighten limits on the dark matter particle cross section. Supernovae will further constrain progenitor properties and provide important new empirical tests for lens modeling. The proposed observations (including F435W) are both timely and urgent. With HST Cycle 23 scheduled through September 2016, we will deliver to the community the best and brightest high-redshift candidates along with cluster lens models in time for the first JWST call for proposals in November 2017.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14097

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14097  
Program Title: Giant impacts on giant planets

Principal Investigator: Imke de Pater

PI Institution: University of California - Berkeley

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

We propose a ToO program to image future impacts on Jupiter and Saturn. To remove the possibility of impact cloud non-detections, the program will be triggered only if an existing impact debris field is seen, an object on a collision course with Jupiter or Saturn is discovered, or an impact light curve is measured with an estimated total energy large enough to generate an impact cloud in a giant planet atmosphere ( $10^{19}$  J).

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

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

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14098

Proposal Category: SNAP  
Scientific Category: Cosmology  
ID: 14098  
Program Title: Beyond MACS: A Snapshot Survey of the Most Massive Clusters of Galaxies at  $z > 0.5$

Principal Investigator: Harald Ebeling

PI Institution: University of Hawaii

Truly massive galaxy clusters play a pivotal role for a wealth of extragalactic and cosmological research topics, and SNAPshot observations of these systems are ideally suited to identify the most promising cluster targets for further, in-depth study. The power of this approach was demonstrated by ACS/WFC3 SNAPshots of 92 X-ray selected MACS and eMACS clusters at  $z > 0.3$  obtained by us in previous Cycles (30 of them in all of F606W, F814W, F110W, and F140W). Based on these data, the CLASH MCT program selected 16 out of 25 of their targets to be MACS clusters. The central role of X-ray luminous clusters in particular for gravitational-lensing work is further underlined by the fact that all but one of the six most powerful cluster lenses selected for in-depth study by the HST Frontier Fields initiative are MACS detections.

We here propose to extend our spectacularly successful SNAPshot survey of the most X-ray luminous distant clusters to a redshift-mass regime that is poorly sampled by any other project. Targeting only extremely massive clusters at  $z > 0.5$  from the X-ray selected eMACS sample, the proposed program will (a) identify the most powerful gravitational telescopes at yet higher redshift for the next generation of in-depth studies of the distant Universe with HST and JWST, (b) provide constraints on the mass distribution within these extreme systems, (c) help improve our understanding of the physical nature of galaxy-galaxy and galaxy-gas interactions in cluster cores, and (d) unveil Balmer Break Galaxies at  $z \sim 2$  and Lyman-break galaxies at  $z > 6$  as F814W dropouts.

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

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14099

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14099  
Program Title: Measuring the L-T transition for a warm Saturn exoplanet

Principal Investigator: Thomas Evans

PI Institution: University of Exeter

The transition between the L and T spectral types in brown dwarf atmospheres is characterized by a reduction in high-altitude clouds and the appearance of strong methane absorption features. Models predict a similar transition for gas giant atmospheres across the 1000-1200K temperature range. To test this theory, we propose to measure a detailed transmission spectrum for HAT-P-18b, a Saturn-mass gas giant with an equilibrium temperature of 850K. Our observations will span the 0.3-1.7 micron wavelength range, with the near-infrared wavelengths allowing us to constrain methane and water absorption, and the optical wavelengths probing alkali metal absorption and high-altitude Rayleigh scattering processes. The latter will allow us to determine whether or not aerosols are present in the atmosphere, addressing a key aspect of atmospheric chemistry. Our measurement for HAT-P-18b will be the first transmission spectrum for a gas giant exoplanet that is predicted to have a high methane abundance, providing unique constraints for atmosphere models.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14100

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14100  
Program Title: A Direct Imaging Experiment to Determine the Origin of H<sub>2</sub> Emission from M dwarf Exoplanetary Systems  
Principal Investigator: Kevin France  
PI Institution: University of Colorado at Boulder

Recent HST-COS observations of M dwarfs hosting exoplanetary systems have detected photo-excited H<sub>2</sub> emission in these environments, in contrast to previous HST-STIS and IUE observations of non-planet hosting M dwarfs where no H<sub>2</sub> emission is observed. Three plausible origins for this emission include: 1) starspots or the stellar photosphere, 2) the heated atmospheres of orbiting planets, or 3) a second generation circumstellar disk produced by atmospheric mass-loss from the planets in these systems. While direct imaging of exoplanets is extremely challenging in the visible/IR owing to the large star/planet contrast ratio, we will take advantage of the favorable star/planet contrast ratio in the FUV to ascertain the origin of the H<sub>2</sub> emission. This proposal will use multi-band FUV imaging with ACS/SBC to directly image one well-positioned M dwarf exoplanetary system to measure the distribution of the H<sub>2</sub> gas: GJ 832, at d = 4.9 pc with a Jovian-mass exoplanet at 0.7 arcseconds separation. Using a combination of F122M, F140LP, and F165LP imaging, we can isolate the relative spatial distributions of Lyman-alpha, C IV, and H<sub>2</sub> providing a stellar reference (C IV from the stellar atmosphere) and two tracers that may originate from exoplanets or their evaporated atmospheres (Lyman-alpha and H<sub>2</sub>). A direct H<sub>2</sub> image of GJ 832b or a circumstellar disk would demonstrate a new observational tool for the detection of planetary systems orbiting low-mass stars and possibly a new means of measuring atmospheric mass loss rates.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14101

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14101  
Program Title: Explosions in Real-Time: Ultra-Rapid UV Flash Spectroscopy of Infant Core-Collapse Supernovae  
Principal Investigator: Avishay Gal-Yam  
PI Institution: Weizmann Institute of Science

Recent advances in transient survey hardware, computing and operations now allow real-time alerts and rapid follow-up spectroscopy of supernovae (SNe) within hours of explosion. The spectra at such early times are a new scientific territory; the first handful of exploratory cases show that optical spectra of massive star Type II SN explosions are dominated by high-ionization recombination lines from circumstellar material ionized by the SN shock-breakout flash ("flash spectroscopy"). UV spectroscopy of infant SN explosions at such early times offers compelling science: a unique insight into the first hours of the explosion, a way to determine the initial metallicity and surface composition of the exploding star (reflected in CSM abundances) as well as a probe of the final year of mass loss leading to the terminal SN event, tracing the final stages of pre-explosion stellar evolution. This is only possible with HST in ultra-rapid ToO mode. Here we propose to undertake such a study of a single, carefully selected SN in cycle 23. This proposal can lead to yet another signature achievement by Hubble.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14102

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14102  
Program Title: The II Zw 40 Supernebula: 30 Doradus on Steroids

Principal Investigator: Claus Leitherer

PI Institution: Space Telescope Science Institute

We propose COS G140L spectroscopy of the enigmatic nearby blue compact dwarf galaxy II Zw 40. The galaxy hosts a nuclear super star cluster with a luminosity 10 times that of 30 Doradus, the most powerful giant HII region in the Local Group. The super star cluster has been suggested to be the ionizing source of a "supernebula" detected via its free-free radiation in the radio. The physical conditions, however, are much more complex, as demonstrated by the detection of the nebular He II and the mid-infrared line of [O IV] 25.9. These lines are unlikely to be related to hot stars and require a different powering source. II Zw 40 shares many similarities with the related blue compact dwarfs NGC 5253 and Henize 2-10, both of which have been studied extensively with HST, yet no ultraviolet spectroscopy has ever been obtained for II Zw 40. This small 4-orbit proposal will provide the necessary UV data to study the massive-star content directly. We will determine reddening, age, and the stellar initial mass function and perform a comparison with the local benchmark 30 Doradus. In particular we will investigate whether the hot stars are able to power the supernebula and the nebular high-excitation lines. Our modeling will utilize the latest generation of stellar evolutionary tracks with and without stellar rotation. If the stars fall short in terms of spectral hardness and luminosity, II Zw 40 may become the second candidate for a central black hole in a young starburst after Henize 2-10.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14103

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14103  
Program Title: Born Small or Gone Small - Determining the Evolutionary State of Comet 252P/LINEAR during its Close Approach to Earth  
Principal Investigator: Jian-Yang Li  
PI Institution: Planetary Science Institute

Comet 252P/LINEAR will have a close encounter with the Earth at 0.0357 AU in March 21, 2016, providing us with a rare opportunity to characterize the nucleus of this potentially unusual comet. Based on the very limited data available, 252P probably has one of the smallest nuclei of all known Jupiter-family comets (JFCs). The primordial size distribution of comets should represent the size distribution of cometesimals during the planetary formation processes. However, the JFC population is expected to be highly evolved, especially at the small-size end. Our goal is to ascertain whether the small size of 252P is primordial and representing the small size end of cometesimals, or highly evolved and represents the end state of a JFC's life. A few other processes related to the evolution of JFCs can also be tested by the characteristics of the nucleus of 252P including its size, shape, and the dust features near the nucleus. The high spatial resolution of WFC3/UVIS, with a projected pixel scale of 1 km/pixel at the comet during the encounter, is critical for this measurement. We request six HST orbits to image the comet with WFC3/UVIS during the close approach.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14104

Proposal Category: GO  
Scientific Category: ISM and Circumstellar Matter  
ID: 14104  
Program Title: The optical-UV extinction law in 30 Doradus

Principal Investigator: Jesus Maiz Apellaniz

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

We propose 1700-10 200 A STIS spectroscopy of over 30 stars in 30 Doradus to derive a detailed (~100 A resolution) family of UV-optical extinction laws. We will extend our previous optical study into the critical UV regime and we will significantly improve on past studies by increasing the wavelength resolution in the optical. Our proposed observations will provide the largest sample of UV spectra ever obtained along sightlines with large total-to-selective extinction ratios ( $R_{5495}$ ), enabling robust analysis of such extinction laws for the first time. The coverage of a wide parameter space in  $R_{5495}$  range and ISM physical conditions will shed new light on debates regarding the origins of differences in extinctions laws, such as the intensity of the 2175 A feature (e.g. the relative roles of metallicity vs. environmental conditions). In addition to the UV spectroscopy, the increased resolution in the optical region will improve the accuracy of the dereddening of stellar photometry and the analysis of the extinction in H II regions as measured by Balmer and Paschen lines. Regarding the latter, we will extract the hydrogen lines in emission in regions adjacent to the stars and compute their ratios. The variation in the strength of these hydrogen emission lines allows a direct comparison between stellar and gas extinction over a large wavelength range. This study is only possible with HST due to the spatial resolution required in the optical and the UV wavelength coverage (making it part of the UV initiative). With only 10 orbits it will produce detailed extinctions laws vital for the realistic dereddening of objects located in distant star-forming galaxies.

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**Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)**

**14105**

**Proposal Category:** GO  
**Scientific Category:** Solar System  
**ID:** 14105  
**Program Title:** Observing Jupiter's FUV auroras near Juno orbit insertion

**Principal Investigator:** Jonathan Nichols

**PI Institution:** University of Leicester

In Cycle 23, the NASA Juno spacecraft will approach and enter orbit around Jupiter. This allows a unique opportunity to obtain HST observations of Jupiter's FUV auroras responding to measured conditions in the solar wind near Jupiter, along with the first with simultaneous in situ magnetic field and plasma measurements within the dawnside outer jovian magnetosphere. These HST observations will exclusively allow us to discover the solution to some of the most pressing and widely-debated open questions in planetary science. Specifically, the science objectives are to:

- (1) Discover the nature of the solar wind interaction at Jupiter
- (2) Determine how the solar wind modulates internal dynamics in Jupiter's magnetosphere
- (3) Determine mass and energy flow of internal processes

We will utilise a Medium program of STIS/FUV imaging and spectroscopic observations, obtained simultaneously with Juno near-Jupiter solar wind data over a solar rotation, along with observations whilst the spacecraft is in the crucial dawn-side magnetosphere. This will reveal what drives the largest magnetosphere in the solar system. This program, which responds to the UV initiative, is only possible during Cycle 23, and HST is the only observatory capable of making these FUV observations, which will yield high-impact results and significantly augment the science return of the NASA Juno mission.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14106

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14106  
Program Title: Probing Ceres' exosphere and water vapor outgassing

Principal Investigator: Lorenz Roth

PI Institution: Royal Institute of Technology

Evidence is mounting that Ceres is a geophysically active icy world. The Herschel telescope measured water vapor above two surface regions and first-view images by the Dawn spacecraft suggest active outgassing above bright, intriguing surface features. Dawn will be in orbit probing the interior and surface of Ceres at least until the end of 2015. The high sensitivity and high resolution of COS provide the unique possibility to obtain supporting FUV spectra to constrain Ceres' exosphere and outgassing. We propose 5 consecutive orbits in the COS G130M mode to measure atomic emissions from O, H and possible trace species in the exosphere. During the ~7.5-hour long visit Ceres' active regions will be targeted on the dayside. Observed diurnal variations will be used to independently differentiate between sublimation and liquid reservoir source regions and detected exospheric signals will be related to surface features characterized by Dawn.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14107

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14107  
Program Title: The Primordial Binary Fraction in Trumpler 14: Frequency and Multiplicity Parameters

Principal Investigator: Elena Sabbi

PI Institution: Space Telescope Science Institute

This is an astrometric proposal designed to identify and characterize the properties of medium- and long-period (orbital periods ranging from 1.8 to 100 years) visual binaries in the mass range between  $\sim 4$  and 20  $M_{\odot}$  in the young compact cluster Trumpler 14 in the Carina Nebula. We aim to probe the virtually unexplored population of intermediate- and high-mass binaries that will experience a Roche-lobe overflow during their post-main-sequence evolution. These binaries are of particular interest because they are expected to be the progenitors of supernovae Type Ia, b, and c, X-ray binaries, double neutron stars and double black holes. Multiplicity properties of young stars can be further used to constrain the outcome of the star-formation process and hence distinguish between various formation scenarios. The medium- and long-period binaries ( $P > 0.5$  yr) are hard to detect and expensive to characterize with traditional ground-based spectroscopy. Knowledge of their orbital properties is however crucial to properly estimate the overall fraction of OB stars whose evolution is affected by binary interaction and to predict the outcome of such interaction. Because of the well characterized PSF of WFC3/UVIS and its temporal stability, HST is the only facility able to characterize the properties of OB-type medium-period binaries in Tr14, and Tr14 is the only nearby high-density OB-type young cluster.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14108

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14108  
Program Title: The Intriguing Case of the (Almost) Dark Galaxy AGC 229385

Principal Investigator: John Salzer

PI Institution: Indiana University System

The ALFALFA blind HI survey has catalogued tens of thousands of HI sources over 7000 square degrees of high Galactic latitude sky. While the vast majority of the sources in ALFALFA have optical counterparts in existing wide-field surveys like SDSS, a class of objects has been identified that have no obvious optical counterparts in existing catalogs. Dubbed "almost dark" galaxies, these objects represent an extreme in the continuum of galaxy properties, with the highest HI mass-to-optical light ratios ever measured. We propose to use HST to observe AGC 229385, an "almost dark" object found in deep WIYN imaging to have an ultra-low surface brightness stellar component with extremely blue colors. AGC 229385 falls well off of all galaxy scaling relationships, including the Baryonic Tully-Fisher relation. Ground-based optical and HI data have been able to identify this object as extreme, but are insufficient to constrain the properties of its stellar component or its distance -- for this, we need HST. Our science goals are twofold: to better constrain the distance to AGC 229385, and to investigate the stellar population(s) in this mysterious object. The requested observations will not only provide crucial insight into the properties and evolution of this specific system but will also help us understand this important class of ultra low surface brightness, gas-rich galaxies. The proposed observations are designed to be exploratory, yet they promise to pay rich dividends for a modest investment in observing time.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14109

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14109  
Program Title: Host galaxy properties of  $z \sim 0.3$  broad-line AGN with direct black hole masses from reverberation mapping  
  
Principal Investigator: Yue Shen  
  
PI Institution: Carnegie Institution of Washington

We propose WFC3 IR and UVIS imaging for a unique sample of ten  $z \sim 0.3$  broad-line AGN with direct black hole (BH) mass measurements from reverberation mapping (RM), resulting from the ongoing Sloan Digital Sky Survey Reverberation Mapping (SDSS-RM) project. Our sample is the first sample of  $z \sim 0.3$  AGN with direct BH masses from RM rather than the less reliable BH mass estimates from single-epoch spectroscopy. The 2-band HST imaging will be used to measure host galaxy properties such as the bulge luminosity and stellar mass in these AGN as well as to quantify the host-free AGN luminosity at rest-frame optical wavelengths, important for measuring the first broad-line region size-AGN luminosity relation at  $z \sim 0.3$ . The measured host properties combined with the RM BH masses from SDSS-RM will be used to investigate the possible evolution of the correlations between BH mass and bulge properties and compared to earlier evolutionary studies based on single-epoch BH masses. The proposed HST imaging, combined with ground-based spectroscopy from the SDSS-RM project, will provide new perspectives on the co-evolution of BHs and host galaxies and the role of AGN feedback in galaxy formation models, and improve the utility of RM on measuring BH masses in broad-line AGN at  $z > 0.3$ .

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14110

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14110  
Program Title: Charaterizing the atmosphere of the enlarged Neptune-mass planet HAT-P-26b

Principal Investigator: David Sing

PI Institution: University of Exeter

Using transits to obtain transmission spectra is a powerful technique to enable detailed studies of exoplanet atmospheres. The Neptune-mass exoplanet HAT-P-26b is one of a small handful of low-mass planets currently accessible to atmospheric measurements. As a large-radius Neptune-mass planet, the planet's low bulk density indicates it must have a substantial atmosphere, with a high hydrogen fraction likely. The atmosphere could have arisen from many different sources resulting in a wide range of possibilities, including ones dominated by hydrogen or heavier species such as water. As the measured mass and radius of a planet do not uniquely specify the atmospheric composition, transmission spectroscopy is the only way to further characterize its chemical makeup. The HST observations proposed here will carry out these vital initial atmospheric observations, with a broad wavelength range covering optical to near-IR sensitive to the expected atmospheric features of water, methane, sodium, potassium, and Rayleigh scattering. With only one in five low-mass exoplanets probed with HST currently showing spectral features, HAT-P-26b is one of the best current candidates likely to have large signals given its large predicted hydrogen fraction. With both optical and near-IR spectra, these observations will measure the atmospheric scale height and definitively determine if the exoplanet has an atmosphere with substantial hydrogen, as predicted by thermal evolution models. HAT-P-26b represents a bridge between the featureless spectra observed in a number of the smaller sub-Neptune/super-Earth exoplanets, and the large-amplitude features observed in hot Jupiters.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14111

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14111  
Program Title: The SN Ia Candidate T Pyxidis: The Mystery of its High Accretion Rate

Principal Investigator: Edward Sion

PI Institution: Villanova University

T Pyx is a recurrent nova that unexpectedly went into outburst in 2011. It has now declined to its quiescent level but it appears to be accreting at a very high rate, possibly driven by irradiation of the donor star by the hot white dwarf or by the hot inner disk. Our team (Godon et al. 2014) has shown, using the light echo distance of 4.8 kpc (Sokoloski 2013), that the white dwarf in T Pyx is actually growing in mass and might be on its way to exploding as a Type Ia supernova.

We propose to continue spectroscopic monitoring of T Pyx with HST COS during Cycle 23, to obtain the first FUV spectrum early in the quiescent period (only four years after its 44 years-delayed outburst). The first FUV spectra of T Pyx following its 1967 outburst were a full 13 years later, in 1980, when IUE was launched. By obtaining FUV spectra with COS at the beginning and at the end of Cycle 23, we will detect any changes in the continuum slope, in the velocity widths and intensities of emission lines. We will use our extensive suite of modeling codes to study the evolution of the accretion disk and also model the stellar photosphere, if detected. Our analysis will yield the accretion rate, WD temperature and elemental abundances. We will compare these data to our values obtained on the decline from outburst and transition into quiescence. Our observations will provide fiducial spectra from 1800Å down to 912Å for this puzzling and pivotal recurrent nova, and would solidify the identification of recurrent novae as Type Ia Supernova progenitors.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14112

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14112  
Program Title: Monitoring the ice plumes of Europa

Principal Investigator: William Sparks

PI Institution: Space Telescope Science Institute

Crucial evidence has been found for plumes of water ice venting from the South polar region of Europa (Roth et al 2014) - spectroscopic detection of off-limb line emission from the dissociation products of water. We are engaged in a sensitive FUV HST imaging program to seek the Europa plumes and exosphere. The data reveal intriguing evidence for off-limb features, both in absorption as Europa transits the face of Jupiter, and emission, away from transit. Subsequent efforts by Roth et al to re-observe the plumes have yielded only upper limits, requiring that they are variable. The cause of the variability has not been established. Here, we propose a modest, sensitive monitoring program to continue to enhance our understanding of this important phenomenon, and to progress towards a determination of the frequency with which they appear. In transit, our strategy places firm limits on, or measurements of, absorbing columns and their distribution with altitude above the surface of Europa. Out of transit, we are sensitive to FUV emission from forward- or back-scattered sunlight and line emission. If the ice plumes of Europa arise from the deep ocean, we have gained access to probably the most astrobiologically interesting location in the Solar System.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14113

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14113  
Program Title: Methane Distribution and Transport in the Active Atmosphere of Uranus

Principal Investigator: Lawrence Sromovsky

PI Institution: University of Wisconsin - Madison

We propose three STIS orbits to obtain spatially resolved 300-1000 nm spectra of the ice giant Uranus and one WFC3 orbit in support of complex STIS calibration corrections. Similar observations made in 2012 revealed an equatorial rise in methane since 2002 and a high-latitude depletion in the north comparable to that seen in the south in 2002, in defiance of expectations. Both low-latitude and polar regions displayed small scale latitudinal variations that are potential indicators of vertical motions. A brightening of the polar region in 2014 suggests either aerosol increases or further decreases in methane or a combination of these effects. The improved view of the north polar region in late 2015 will allow extension of our analysis to higher latitudes and measurement of temporal changes at most latitudes accessible in 2012. We will use differences in methane and hydrogen absorption near 825 nm to constrain the methane distribution over the latitude range from 25 S to 90 N. During its orbits the STIS slit will be aligned parallel to Uranus' polar axis and stepped from the edge to the center of the disk, taking advantage of the zonal symmetry of Uranus to reduce total observing time by half. These results will be relevant to extra-solar science, as Uranus represents a size class that is abundant among Kepler extra-solar planet candidates. HST provides wavelength coverage with spectral and spatial resolution not available from any other facility due to Uranus' small angular size, and this capability may not be available in the near future due both to limited HST lifetime and the expected eventual formation of an obscuring north polar haze on Uranus.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14114

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14114  
Program Title: A Wide-Field WFC3 Imaging Survey in the COSMOS Field

Principal Investigator: Pieter van Dokkum

PI Institution: Yale University

Wide-field surveys with HST are generally inefficient, as guide star acquisitions impose a minimum exposure time of 0.5 -1 orbit per pointing. We propose to use an innovative method to observe 456 WFC3 F160W pointings, covering 0.6 square degrees, in only 57 orbits. The method utilizes the fact that HST drifts by only a very small amount in the 25 seconds between non-destructive reads of unguided exposures. By observing the deep UltraVISTA/SMUVS strips in the COSMOS field we leverage the ACS F814W data in that field as well as the deepest IRAC and ground-based near-IR data in existence over such a large area. The data reach a 5 sigma point source depth of  $H(AB)=25.3$ . Extending the 900-orbit CANDELS program, this will more than triple the area covered by near-IR imaging at HST resolution. The primary science goals of our small team center around the evolution of massive galaxies: we will measure the relation between their star formation rate and structure at  $2 < z < 3$ , identify candidate compact massive galaxies in the process of formation, and determine their major merger rate from close pair statistics. As many other science questions can be answered with these data we waive the proprietary time and will make reduced mosaics available to the community.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14115

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14115  
Program Title: The Stellar Origins of Supernovae

Principal Investigator: Schuyler Van Dyk

PI Institution: California Institute of Technology

Supernovae (SNe) have a profound effect on galaxies, and have been used as precise cosmological probes, resulting in the Nobel-distinguished discovery of the accelerating Universe. They are clearly very important events deserving of intense study. Yet, even with over 6400 IAU-designated SNe, we know relatively little about the stars which give rise to these powerful explosions. The main limitation has been the lack of spatial resolution in pre-SN imaging data. However, our team has been at the vanguard of directly identifying SN progenitor stars in HST images. From this exciting line of study, we have learned that Type II-Plateau SNe appear to primarily arise from relatively low mass (8 to 20 Msun) red supergiants, leaving a puzzle as to what is happening to more massive stars. Additionally, evidence is accumulating that the progenitors of Type II-narrow SNe may be related to luminous blue variables. However, the nature of the progenitors of Type Ib/c SNe, a subset of which are associated with the amazing gamma-ray bursts, remains ambiguous. Furthermore, we remain in the continually embarrassing situation that we still do not yet know which progenitor systems explode as Type Ia SNe, which are being used for precision cosmology. In previous Cycles we have had great success with our approved ToO programs. As of this proposal deadline, we have had one trigger (SN 2014dt) completed so far and one pending (SN 2015G) with our Cycle 22 program. The compelling scientific questions lead us to continue this project to determine the identities of the progenitors of 4 SNe within, generally, about 20 Mpc, which we expect during Cycle 23, through ToO observations using WFC3/UVIS.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14116

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14116  
Program Title: A Search for A Light Echo from Supernova 2013ej

Principal Investigator: Schuyler Van Dyk

PI Institution: California Institute of Technology

Light echoes from supernovae are fascinating phenomena and can probe both the circumstellar and interstellar structures, the size distribution and chemical composition of the scattering dust, and the detailed history of the outburst giving rise to the echo. Although light echoes from recent extragalactic supernovae could well be a common occurrence, observations which spatially resolve echoes are relatively rare. The main obstacle to resolving the echo is that the SN host galaxies must be relatively nearby, although, even then, the structures can only be revealed by the superior angular resolution of HST. The light echo of a SN results from the luminous ultraviolet (UV)/optical pulse scattered by dust in the SN environment. In particular, we can witness a record of the bright, rapid, elusive flash of X-ray/UV emission emerging as the SN shock breaks through the massive envelope around the progenitor star. We propose to search for a light echo around the recent Type II-Plateau Supernova 2013ej in the nearby, nearly face-on spiral host galaxy Messier 74. Previous HST imaging since the explosion has not revealed an echo. However, those observations were too soon, when the SN was still on the plateau and quite bright. The WFC3/UVIS multi-band imaging we propose will be late enough, near day 900 of the SN age, and sensitive enough to detect a possible light echo. There are very few other supernovae this nearby, at an old enough age, where adequately resolving the echo is possible. Cycle 23 is the time to do this for SN 2013ej, taking particular advantage of the UV.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14117

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14117  
Program Title: A Young White Dwarf with an Infrared Excess: Dust Disk or Substellar Companion?

Principal Investigator: Siyi Xu

PI Institution: European Southern Observatory - Germany

We recently discovered the youngest white dwarf with 2-8 micron emission. Its SED can be fit by either a dust disk or a substellar companion. Two unique properties of this object favor the substellar companion hypothesis: (i) the color of the infrared excess; (ii) the non-detection of heavy elements with Keck/HIRES observations. We propose to use COS to look for heavy elements; which would be about two orders of magnitude more sensitive than the HIRES studies. If heavy elements are detected, the excess emission is likely to come from dust and this would be the hottest white dwarf with a ~1200 K dust disk; otherwise, the excess is likely to come from a substellar companion, possibly a rejuvenated planet, which would rank among the closest and lowest mass companions known to orbit a white dwarf.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14118

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14118  
Program Title: The end of the White Dwarf Cooling Sequences of Omega Centauri

Principal Investigator: Luigi Bedin

PI Institution: Osservatorio Astronomico di Padova

The white dwarf cooling sequence (WD CS) lies in the least-explored region of the color-magnitude diagram of old stellar populations. Deep imaging with HST has reached for the first time the end of the WD CS in three "classical" old globular clusters, M4, NGC6397, and 47 Tuc. While each of these clusters hosts multiple populations, they do not show a large range of initial He abundances, and their WD CSs are consistent with what predicted for single-population systems.

Here, we propose to reach the end of the WD CS in a quite different type of cluster. Omega Centauri has long been known to host multiple stellar populations, with a large spread also in [Fe/H] and, most importantly, a large range of initial He, as can be deduced from its main sequence. It has already been established that the upper part of Omega Centauri's WD CS is bifurcated into two sequences. A previous analysis has hypothesised that the bright WD CS consists of a standard CO-WD sequence, and a redder sequence of low-mass WDs with both CO and He-cores. The bluer of two WD CS is populated by the evolved stars of the He-normal component, while the redder WD CS hosts the end products of the He-rich population. This points to a clear connection between GCs with enhanced He populations, and the morphology of their WD CS.

Omega Centauri is close enough that its entire WD CS is within the reach of HST. Observing the whole WD CS of this cluster down to its termination will provide a clear solution for the origin of the multiple WD CS of this cluster, and answer some important key questions about stellar evolution for He-enriched populations.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14119

Proposal Category: SNAP  
Scientific Category: Hot Stars  
ID: 14119  
Program Title: Understanding Stellar Evolution of Intermediate-Mass Stars from a New Sample of SiriusB-Like Binaries  
  
Principal Investigator: Luciana Bianchi  
  
PI Institution: The Johns Hopkins University

The population of very hot white dwarfs (WD) is elusive at all wavelengths except the UV. These stars have small radii, resulting in low optical luminosities, and high temperatures, to which optical colors are insensitive. Yet, they are extremely relevant astrophysical probes; their progenitors enrich the interstellar medium with carbon, nitrogen, and other important elements, shedding most of their initial mass in late evolutionary phases. But our knowledge of mass loss and envelope enrichment in the AGB phase, and the link to subsequent evolution of the remnant to the WD phase, has critical gaps which limit our understanding of galaxy chemical evolution.

From the GALEX UV surveys matched to optical photometric and spectroscopic surveys, we extracted a SNAP sample of hot WDs in binary systems with companions of spectral type from late B to early K. The pairs are unresolved in GALEX and SDSS imaging, but will likely be resolved with HST in most cases. We propose WFC3 imaging in 5 filters (F218W F275W F336W F475W F606W) that will allow individual SED measurements for both stars in each resolved pair, to derive separation and stellar parameters. For the resolved pairs, we will be able to constrain initial and current WD mass, as well as age and luminosity. Results will address the open questions of: initial-final mass relation, which maps the final WD mass to the initial mass of the progenitor and is critical for understanding chemical enrichment of the interstellar medium, degenerate mass-radius relation, binary mass function, and binary evolution, over a wide range of initial masses.

The UV measurements are indispensable to characterize the hot WD.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14120

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14120  
Program Title: He II emission as a tracer of ultra-low metallicity and massive star evolution

Principal Investigator: Jarle Brinchmann

PI Institution: Leiden Observatory

The He II 1640 emission line is arguably the primary probe for detecting ultra-low metallicity star formation in the high redshift Universe but even at  $z \sim 0$  our understanding of it is woefully incomplete. Since the first signs of Population III star formation at high- $z$  is even likely to be seen intermixed with more metal rich star formation, we need a solid understanding of the massive stellar population responsible for the excitation of He II at non-zero metallicity but this is currently lacking.

The main reason we do not fully understand the physics behind narrow-line He II emission at low metallicity is that we do not have any direct observational probes of the massive stars responsible for the ionizing radiation. Until we understand this, a significant uncertainty will remain in any interpretation of nebular He II 1640 at high redshift.

Here we propose to use COS to carry out the first systematic study of the massive stellar content in galaxies selected to have He II in emission. With this we will a) study in detail the population of massive stars responsible for exciting both narrow and broad He II, b) rigorously test recent claims for significant pockets of ultra-low metallicity star forming gas at  $2 < z < 7$  galaxies based on detecting narrow He II 1640 emission in deep spectroscopy.

This survey has only now become possible because we have carried out a systematic search for He II 4686 emitting galaxies at  $z \sim 0$ . This allows us to accurately predict He II 1640 fluxes and therefore optimally design a COS observing program for these sources. A survey based on targeting UV bright galaxies/star forming regions would not be able to tackle these questions.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14121

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14121  
Program Title: Probing the accretion disk in the Seyfert 1 NGC 4593

Principal Investigator: Edward Cackett

PI Institution: Wayne State University

More than forty years since nearby AGN were suggested to be powered by accretion onto supermassive black holes we still do not have strong observational constraints on the structure of AGN accretion disks. However, wavelength-dependent continuum reverberation provides a unique probe of the disk. Hot, inner parts of the accretion disk respond to irradiating, variable, X-ray flux before the cooler, outer parts, simply due to light crossing time. Hence, time lags between UV (hot) and optical (cool) lightcurves are observed. But, for the best-studied source, NGC 5548, the measured lags appear anomalously large for its mass and accretion rate. Either our understanding of AGN accretion disks is wrong, or, the continuum is significantly contaminated by more slowly varying components arising at larger radii. Thus, further high quality lag measurements are needed in order to address this. The bright, nearby AGN NGC 4593 will be in the Kepler field in July - September 2016, providing a remarkably high-cadence (every 30 min) and high S/N (0.1% photometry) broadband continuum lightcurve. Here, we are proposing a 1-month, daily monitoring campaign of NGC 4593 with HST/STIS spectroscopy to measure wavelength-dependent lags. We will utilize the unprecedented quality of the Kepler lightcurve as a reference band to obtain high-fidelity lag measurements in order to probe the accretion disk in this object. As a secondary goal we will also obtain lightcurves from strong optical and UV emission lines to probe the stratification of the broad-line region.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14122

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14122  
Program Title: Unveiling stellar populations in absorption-selected galaxies

Principal Investigator: Lise Christensen

PI Institution: University of Copenhagen, Niels Bohr Institute

Metal absorption lines in Damped Ly-alpha systems (DLAs) allow us to trace the metallicity of galaxies back to redshifts  $z > 5$ . Therefore, understanding the galaxies that host the DLAs is our best strategy for understanding the physics of galaxy formation and evolution in the early universe. The average DLA arise in low-mass galaxies and detecting these in emission has been difficult. Metal-rich absorbers have proven to arise in brighter galaxies, and we have a growing number of emission line detections from DLA galaxies with ground-based VLT spectra. Combining spectral information of the DLA system with imaging of the host galaxy continuum emission gives unparalleled information of the nature of absorption-selected galaxies and their gaseous halos.

We propose to obtain multi-band images in 3 filters covering the optical to near-IR for seven  $z > 2$  DLA systems where we already have a spectroscopic confirmation of the host galaxy. High spatial resolution imaging allows us to accurately measure the impact parameters, morphologies, derive stellar masses, stellar population ages and dust reddening from SED fits, and allow us to investigate several scaling relations such as the mass-metallicity relation. This program will more than double the number of high- $z$  DLA galaxies for which we have detected the stellar continuum. This is science that is impossible to do from the ground due to the glare of the background QSOs and hence the data will be an important part of the legacy of HST. We can now finally begin to investigate absorption selected galaxies on the same footing as luminosity selected ones and probe the build-up of metals in the outskirts of galaxies in the early universe.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14123

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14123  
Program Title: Does All The Lyman Continuum Emission Escape From Young, Low Mass Starbursts?

Principal Investigator: James Colbert

PI Institution: Jet Propulsion Laboratory

Searches for escaping Lyman continuum emission from star-forming galaxies have been largely unsuccessful across a wide range of redshifts, seemingly in contradiction with the observed ionized Universe. However, the main focus of these searches has been massive galaxies, despite theoretical studies that predict a higher escape fraction of ionizing radiation in galaxies at the low mass end. We propose to measure the escaping Lyman continuum emission from a sample of 11 low mass, emission line galaxies at  $1.2 < z < 1.4$ , selected from the 3DHST survey, using the ACS SBC camera and its F150LP filter. These low mass emission line galaxies have all been selected to have very high ( $> 190$  Angstrom) H-alpha equivalent widths, indicating that their stellar populations are both very young and very low metallicity, similar to the primordial star formation believed to have re-ionized the Universe. We will be sensitive to an intrinsic escape fraction of 5% for these low mass sources. Efficient searches for escaping Lyman continuum emission require HST ultraviolet imaging targeting galaxies at  $z=1-2$ , because of the rapid rise in IGM opacity with redshift.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14124

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14124  
Program Title: Pushing to Sub-Gyr Globular Cluster Ages: the IR CMD of NGC 6397

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. 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 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. 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 obtain the first IR color-magnitude relation of stars for a truly metal-poor GC, NGC 6397. We will establish the most accurate age for the cluster to date, with sub-Gyr precision. Combining this observation with our analysis of publicly available data of 4 other more metal-rich GCs from MAST will establish an independent and sensitive test to the age-metallicity relation of clusters.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14125

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14125  
Program Title: A Remarkable Recurrent Nova in M31: The Leading Single Degenerate Supernova Ia Progenitor Candidate(?)  
Principal Investigator: Matthew Darnley  
PI Institution: Liverpool John Moores University

M31N 2008-12a is the single most important nova system in M31. With its one-year recurrence period, high-mass white dwarf, high mass accretion rate, low peak optical luminosity, and low ejecta mass and velocity, this system is a leading Supernova Type Ia single-degenerate progenitor candidate. The rapid decline from optical peak and the distance of M31 necessitate a request for disruptive target of opportunity observations. Here we propose early eruption UV spectroscopic observations, followed by UV and optical photometric monitoring during the super soft source phase; providing true panchromatic coverage, then continuing into the subsequent decline. Spectroscopically we will study the composition of the ejecta, including probing the underlying composition of the white dwarf, C-O vs. O-Ne, which is key to the ultimate fate of this system (SNIa vs. accretion-induced collapse), as well as the emission mechanisms in the ejecta exploring evidence for a long lived stellar wind. Photometrically, we will monitor the decline towards quiescence, disentangling NUV contributions from the cooling white dwarf and perhaps the surviving accretion disk. The regularity of eruptions of M31N 2008-12a are unprecedented and this is the only thermonuclear nova system where we can accurately predict eruptions. The unique UV capabilities of HST therefore allow us to study the physics of this vitally important system even at the great distance of M31.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14126

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14126  
Program Title: Startlingly fast evolution of the Stingray Nebula

Principal Investigator: Zachary Edwards

PI Institution: Louisiana State University and A & M College

The Stingray Nebula provides the unique opportunity to watch the ionization of a planetary nebula, a helium shell flash, and the evolution of the central star. Importantly, before 1980 the Stingray's spectrum was characteristic of a B1I star, then in 1990 the Stingray's spectrum was dominated by bright emission lines characteristic of a young planetary nebula, indicating the fast evolution of this system. Despite its fast evolution, the Stingray has not been imaged for 15 years. We propose to use 2 orbits of HST, using WFC3, to define the evolution of this planetary nebula and its central star. These observation will address three science goals: First, measure the differential expansion of the shell from 1992 to present. Second, detect brightening from the the fast wind of the 1980s ionization event impacting the inside of the planetary nebula shell. Third, define the motion of the central star through the HR diagram to provide quantitative measures for comparison to theory. This program cannot be done from ground-based observatories since it requires HST's angular resolution to detect expansion, and resolve the central star from the surrounding nebula.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14127

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14127  
Program Title: First Measurement of the Small Scale Structure of Circumgalactic Gas via Grism Spectra of Close Quasar Pairs  
  
Principal Investigator: Michele Fumagalli  
  
PI Institution: University of Durham

In our current structure formation paradigm, the supply of cool gas in the circumgalactic medium (CGM) provides the primary fuel for galaxy formation. Hydrodynamic simulations predict that the cool CGM will self-shield, and hence be easily detectable in absorption as optically-thick Lyman limit systems (LLSs). Several decades of absorption line spectroscopy have established the abundance and properties of these LLSs, however their relationship to populations of galaxies and to our theoretical picture of structure formation remains a mystery. We propose to solve these puzzles with WFC3/G280 grism spectra of 55 quasar pairs at small separation, to simultaneously pierce LLSs with two sightlines at small impact parameters (10-500 kpc). This novel experiment will resolve the small-scale structure of optically thick gas in the CGM, and provide the first measurement of the two-point correlation function of LLS pairs. This new observable will place LLSs in the clustering hierarchy to finally determine their relationship to observed populations of distant galaxies. These efforts are complemented by existing ancillary ground-based spectroscopy, which reveals the kinematics of related metal-line absorption, providing unprecedented constraints on the infalling and outflowing gas kinematics around galaxies hosting LLSs. Our experiment will also provide new insights into the small-scale variations of metal enrichment in the halos of distant galaxies. Direct comparison to our state-of-the-art hydrodynamic simulations will provide a new quantitative test of the current galaxy formation picture, including galactic outflows and the existence of cold accretion.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14128

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14128  
Program Title: The dawn of rocky planet formation

Principal Investigator: Mark Hollands

PI Institution: The University of Warwick

The vast majority of all known planet host stars will eventually evolve into white dwarfs. With the parameter space of the known planetary systems ever increasing, it is now clear that a significant fraction of these systems will survive this evolution (including the solar system from Mars outwards). Equally, many of the known white dwarfs were once planet hosts, and some of them very likely still host the remnants of planetary systems. In fact, we already know the signposts of such evolved planetary systems: metal-pollution of the otherwise pristine H/He atmosphere of a white dwarf by accretion of planetary debris. The identification of the coolest and hence oldest metal-polluted white dwarfs opens the exciting potential to investigate the history of rocky planet formation in the Galaxy. Using the Sloan Digital Sky Survey, we are now discovering large numbers of such systems: white dwarfs that have accreted rocky bodies of at least the mass of Ceres, the largest asteroid known in the solar system, and that already finished their main-sequence life when the Earth was just being formed. Precise measurements of the system ages, and accurate chemical abundances of the planetary debris require improved model atmospheres and input physics to deal with the extremely dense atmospheres of these cool white dwarfs, which we have computed. Because the strongest absorption features lie in the near-ultraviolet, we request HST STIS observations of three systems spanning the relevant range of temperatures to test and calibrate our calculations. With those calibrations in hand, we will then be able to analyse the full sample using only the available optical data.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14129

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14129  
Program Title: UV spectroscopy of supernova-companion interaction in a Type Ia supernova

Principal Investigator: Shrinivas Kulkarni

PI Institution: California Institute of Technology

One of the two models proposed for Ia supernovae is a white dwarf accreting matter from a hydrogen companion. A massive enough white dwarf is expected to explode. A fundamental expectation of this model is the collision of the blast wave with the donor star. Such a collision signature in the form of a strong declining UV pulse has been seen for one SN. Here, we propose to undertake STIS UV spectroscopy of one Ia supernova with similar strong UV emission. The spectra will constitute strong proof for this model, probe the chemical abundance of the outermost layers of the ejecta. A second epoch of spectroscopy would allow us to look for signature of residual emission from the interaction and thus provide less disruptive ways to determine the fraction of SNe Ia produced by this channel.



Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14130

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14130  
Program Title: Down the Tubes: Vetting the Apparent Water-rich Parent Body being Accreted by the White Dwarf GD 16  
Principal Investigator: Carl Melis  
PI Institution: University of California - San Diego

How water is distributed in a planetary system critically affects the formation, evolution, and habitability of its constituent rocky bodies. White dwarf stars provide a unique method to probe the prevalence of water-rich rocky bodies outside of our Solar system and where they preferentially reside in a planetary system. However, as evidenced by the case of GD 362, some parent bodies that at first glance might appear to be water-rich can actually be quite water-scarce. At this time there are only a small number of plausibly water-rich rocky bodies that are being actively accreted by their host white dwarf star. Given such a sample size it is crucial to characterize each one in sufficient detail to remove interlopers like GD 362 that might otherwise affect future statistical analyses. In this proposal we seek to vet GD 16, a water-rich candidate yet to be observed with HST-COS that is the brightest remaining such target in the UV.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14131

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14131  
Program Title: Origin of double peaks in Lyman-alpha spectra: diffuse halos or Lyman continuum leakage?  
Principal Investigator: Ivana Orlitova  
PI Institution: Astronomical Institute, Academy of Sciences of CR

The Lyman-alpha (Ly $\alpha$ ) line is a tool of prominent cosmological importance. Most of the observed spectra show P-Cygni profiles, but a fraction of them are double-peaked, interpreted as radiative transfer effects in static media in the realm of the common expanding shell models. However, several studies indicate that this interpretation is inconsistent with ancillary data. We propose a new theoretical scheme for the origin of 2 types of double peaks: 1) Our simulations show that double peaks arise in Ly $\alpha$  "halos", i.e. diffuse Ly $\alpha$  emission in circum-galactic gas. 2) We predict that no Ly $\alpha$  halos are expected at galaxies with escaping Lyman continuum (LyC), and in this case narrow Ly $\alpha$  double peaks result from radiative transfer in low column density of neutral hydrogen. We propose testing these two schemes on Green Peas, a class of local, compact, low-mass, low-metallicity galaxies, which comprise some of the strongest candidates for LyC escape. Most of their HST/COS Ly $\alpha$  spectra are double-peaked, carrying the signal from the entire galaxy and its Ly $\alpha$  halo, thanks to the target compactness. We have selected 4 targets with very different Ly $\alpha$  spectra: narrow and broad, strong and weak double-peaks, and one single-peak spectrum. We will image them in Ly $\alpha$ , FUV continuum and H-alpha. We expect detecting 2 large halos (plus one available in the archive), while the other 2 targets are probable LyC leakers. We will search for connections between spatial Ly $\alpha$  properties (halo extent, surface brightness profile, flux concentration) and spectral Ly $\alpha$  signatures (peak separation, blue peak strength). Our results will have impact on Ly $\alpha$  data interpretation both at low and high redshift.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14132

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14132  
Program Title: The spatial distribution of hot stellar populations in M31's globular clusters

Principal Investigator: Mark Peacock

PI Institution: Michigan State University

We propose to utilize HST's unique combination of spatial resolution and UV sensitivity to accurately determine the far-UV (FUV) properties of M31's globular clusters (GCs) via new ACS/SBC F140LP observations. These observations will enable the study of horizontal branch (HB) stars beyond the Milky Way, providing the vital new data needed to understand these stars and the second parameter problem. In particular, we will determine whether stellar interactions enhance the formation of extreme-HB stars, a question still debated based on the limited data provided by the Galactic GCs. These data will also be sensitive to a signature of multiple stellar populations in these clusters - a centrally concentrated population of FUV bright He-enhanced second generation HB stars. Such a population is predicted and its detection would provide the best evidence to date of multiple populations in GCs beyond the Milky Way and its satellites. Our proposed FUV observations leverage existing HST data from the 'Panchromatic Hubble Andromeda Treasury` (PHAT) survey, which already provides near-UV, optical and near-IR photometry of these clusters. By adding the FUV band to these clusters, we can study their interesting hot stellar populations - enabling significant new science, with modest new HST commitment. The combined dataset will produce the best multiwavelength photometry that is (or is likely to become) available for any globular clusters. As such, it will be of lasting benefit in constraining stellar populations models and enable better understanding of rest-frame FUV spectra of galaxies.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14133

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14133  
Program Title: Establishing an evolutionary sequence for disintegrated minor planets

Principal Investigator: David Polishook

PI Institution: Weizmann Institute of Science

The exciting HST discovery of the asteroid P/2013 R3 disintegrating into multiple ~100 meter-size bodies (Jewitt et al. 2014) gave us a first "live" glimpse of the formation of a multiple system. The R3 event is explained by the rotational-disruption mechanism while other causes have been rejected. It is clear that rotational-disruption events contribute to the overall size-frequency distribution of asteroids and are related to the diversity of observed binary and multi-component systems, although different models of disruption have been suggested. We aim to determine if R3-like events are rare by using HST's WFC3/UVIS to observe 6 asteroids known to have recently split ( $\sim 10^5$ - $10^6$  yr) into at least two objects by the rotational-disruption mechanism. With HST we will search for additional bodies orbiting the larger member of these disrupted asteroid pairs. Finding satellites around known disrupted asteroids will suggest that multi-body disintegration processes are frequent and relevant to binary formation. A null-result will suggest that disintegration events like that of R3 are rare. In addition, both positive or null results will constrain the size distribution of the remnants of rotational-disruption events and will provide a direct probe of asteroids' internal structure and strength.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14134

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14134  
Program Title: Spectral Diagnostics for the Reionization Era: Exploring the Semi-Forbidden CIII] Emission in Low Metallicity Green Pea Galaxies  
Principal Investigator: Swara Ravindranath  
PI Institution: Space Telescope Science Institute

Identifying the sources of reionization at  $z > 6$  is one of the primary science goals of cosmology and the main driver for upcoming large telescopes. The main tools for confirming the redshifts and tracing the earliest stellar population are the UV continuum and Ly-alpha emission. At  $z > 6$  and further into the reionization era these UV photons are severely quenched by the largely neutral IGM, making it crucial to seek other diagnostics. The semi- forbidden CIII]1909 emission is emerging as promising tool based on the strength and frequency of its observation in low metallicity galaxies at  $z > 2$ . We propose to use the HST STIS to observe the local analogs of such a population locally, which are the recently discovered ``Green Pea" galaxies. We propose to observe the CIII] line and use it with the shorter wavelength observations in the HST archive to (1) establish the ubiquity of this line, (2) calibrate the CIII] emission strength against Ly-alpha to explore its usefulness as a potential redshift indicator, (3) derive C/O ratios from CIII]1909 and OIII] 1663 lines, and study their dependence on metallicity, and (4) construct high quality composite rest-UV spectra of these star-forming dwarfs. These new calibrations and templates will serve as important diagnostic tools for high redshift galaxies.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14135

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14135  
Program Title: Are High-Redshift Spectroscopic Black Hole Mass Estimates Biased?

Principal Investigator: Gordon Richards

PI Institution: Drexel University

Black hole (BH) masses estimated from single-epoch spectroscopy underlie our understanding of the build-up of BHs from high redshift to the present, but are currently based on a small sample of low-L, low-z "reverberation mapped" (RM) AGNs. The existing sample of RM AGNs appears to be biased against quasars where a radiation line driven disk-wind dominates the broad emission line region (BELR). As such, we propose UV spectroscopy of 25 SDSS quasars at  $z \sim 0.5$  that have luminosities comparable to the existing RM quasars, but that are more representative of the BELR properties of the average quasar. These data will enable us to confirm the bias in the RM quasar sample and lay the groundwork for reverberation mapping of quasars where winds affect the BELR. This work is important because successful RM measurements of local AGNs have not been extended to the high-z, high-L regime, requiring extrapolation methods from low redshift. The best tool for this work comes from UV observations of the CIV emission line region where it is possible to distinguish between virial- and wind-dominated BELRs. These measurements will further enable us to inter-compare BH masses computed using measurements from CIV, MgII, and Hbeta for each quasar. For this work we require spectral coverage

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14136

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14136  
Program Title: Search for material around Chiron

Principal Investigator: Bruno Sicardy

PI Institution: Observatoire de Paris

Chiron is an active Centaur object of radius  $\sim 110$  km orbiting between Saturn and Uranus. Its size and orbital elements are similar to those of the largest Centaur known to date, Chariklo (radius  $\sim 120$  km). In 2013, a stellar occultation revealed the surprising presence of two narrow and dense rings around the latter body (Braga-Ribas F. et al., Nature, 2 April 2014), showing that rings are not an exclusivity of the giant planets and may be a more common feature than previously thought. A stellar occultation by Chiron observed in 2011 actually revealed the presence of sharp features that could be caused by a shell of material or cometary jets around Chiron (Ruprecht et al. 2015), a conclusion supported by the fact that Chiron (contrarily to Chariklo) does exhibit a cometary-like activity. Conversely, analyzing results from three stellar occultations (in 1993, 1994, 2011), Ortiz et al. (2015) show that the detections of secondary events could be explained by the presence of a dense and narrow rings orbiting at about 325 km from Chiron's center. Our goals here are to (1) Search for jets and faint material around Chiron (at more than 2,000 km from the central body), (2) search for faint satellites, (3) Constrain the presence of close-in ring structures, and (4) get multi-wavelength photometry to constrain the material composition. This would help us to assess how unique Chariklo's rings are, and to see whether the material surrounding both objects has something to do with a cometary activity.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14137

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14137  
Program Title: Damped Lyman-alpha Systems in the Disks of Low-z SDSS Galaxies on Top of QSOs

Principal Investigator: Lorrie Straka

PI Institution: Universiteit Leiden

Damped Lyman-alpha (DLA) and sub-DLA absorbers dominate the mass density of neutral gas in the Universe ( $\log N(\text{HI}) > 20.3$  and  $19.0 < \log N(\text{HI}) < 20.3$  respectively) and are easily detected in the spectra of background QSOs. Though they have been studied for decades, the relationship between DLAs, sub-DLAs, and the properties of their host galaxies remain an open question. This class of objects, being cold and neutral, have long been believed to be critical in the formation of galaxies and ideal staging grounds for new star formation. In fact, many studies suggest they may arise in galaxy disks or, due to their low metallicity nature, dwarf galaxies. The distinction is of great importance and requires the identification of as many host galaxies as possible, which is easiest at low-z due to the decrease in surface brightness with distance.

We present a sample of 10 FUV-bright QSOs probing the disks of foreground galaxies at  $z < 0.14$  from the SDSS. These galaxies have known star formation rates,  $E(B-V)$ , and most importantly: imaging detections detailing their morphology and orientation relative to the QSO line of sight. We propose to use HST/COS to determine the neutral hydrogen column density of these galaxies in order to constrain the host environments of DLAs and sub-DLAs. We will use the spectra to determine metallicity gradients and HI covering fraction at  $z < 0.14$ . Finally, we will determine correlations between the HI absorption strength with the galaxy orientation and morphology that have been found in the literature for Mg II and Na I D.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14138

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14138  
Program Title: Absolute Measurement of the Cosmic Near-Infrared Background Using Eclipsed Galilean Satellites as Occulters  
  
Principal Investigator: Kohji Tsumura  
  
PI Institution: FRIS, Tohoku University

The Cosmic Infrared Background (CIB) as an integrated history of the early universe is important for the study of unresolved star formation. However, previous CIB measurements suffer from residual contamination from strong foreground emission (e.g. the zodiacal light). We propose to observe Galilean satellites eclipsed in the shadow of Jupiter as occulting spots at near-infrared wavelengths in order to detect the absolute CIB intensity without any zodiacal light subtraction error. The zodiacal light originates inside the orbit of Jupiter; since the Galilean satellites in eclipse shield all light beyond the Jovian orbit, they should be detected as 'dark spots' if the strong CIB implied by previous observations exists. The intensity deficit of this dark spot relative to the surrounding sky directly measures the brightness of the CIB, free from any assumptions about the zodiacal light. The size of the dark spot is approximately 1 arcsec in diameter and the predicted surface brightness is 50 nW/m<sup>2</sup>/sr lower than that of surrounding sky brightness, which can be detected by WFC3 IR imaging with F167N filter for one orbit integration with S/N=10 even in the strong Jovian stray light environment.

Our previous observations revealed that deep eclipses are required to reduce the effects from forward-scattered sunlight within the Jovian upper atmosphere. The deepest such eclipses will occur in this Cycle 23 season, and next chance to observe such deep eclipses is six years after owing to Jupiter's orbital period. Therefore, observations in this Cycle 23 are highly required. These new observations will definitively prove if the technique can be made to work.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14139

Proposal Category: GO  
Scientific Category: ISM and Circumstellar Matter  
ID: 14139  
Program Title: Imaging Polarimetry of Light Echoes around SN 2014J

Principal Investigator: Lifan Wang

PI Institution: Texas A & M University

Because of the proximity of the Type Ia SN 2014J, HST can resolve light echoes from dust with an impact parameter of just a few light years. Only dust so close to the supernova can scatter light at large angles into the line of sight. Therefore, polarization of a light echo is an ambiguous criterion for the identification of nearby matter, and such large-angle scattering will induce maximum polarization  $\sim 50\%$ , which is not expected for double-degenerate progenitors. Polarized echoes also offer the unique opportunity to determine separately the extinction and scattering properties of the dust, opening the door to understanding the enigmatic extinction properties observed with many SNe Ia. Since high-polarization echoes arise from large-angle scattering, the involved dust must be on nearly the same celestial sphere as the SN. This enables a simple geometric absolute distance measurement. We aim at advancing all three of these important topics simultaneously through imaging polarimetry of SN 2014J at 4 epochs.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14140

Proposal Category: GO  
Scientific Category: ISM and Circumstellar Matter  
ID: 14140  
Program Title: Using UV-bright Milky Way Halo Stars to Probe Star-Formation Driven Winds as a Function of Disk Scale Height  
Principal Investigator: Jessica Werk  
PI Institution: University of California - Santa Cruz

Galactic-scale winds driven by star formation are a common feature of galaxy formation models, and are observed ubiquitously from the local Universe to  $z \sim 6$ . However, empirical constraints on the radial density profile and total spatial extent of these winds have been very challenging to obtain. We have devised a simple experiment using blue horizontal branch (BHB) stars in the halo of the Milky Way that will directly map the extent and density of diffuse, ionized outflows from the Galactic disk to the halo. We propose to take COS FUV spectra of 7 BHB stars that evenly sample the range of scale heights from 3 - 13 kpc, lying perpendicular to the disk of the Milky Way, extending from the position of the sun. This study will allow us to unambiguously track inflowing and outflowing material from the Milky Way via absorption component blueshifts and redshifts, respectively. This program will yield the first direct observational determination of the scale height to which star-formation-driven winds propagate in the halo. We will additionally probe the change in the gas density as it extends into the halo, and approximate a mass of metals as they leave the disk and become integrated into the halo. Our proposed experiment will yield the most detailed constraints on the physical state and energetics of gas in a large-scale galactic wind to date. Such constraints are fundamental to understanding the impact of feedback processes on galaxies and in fueling the buildup of their gaseous environments.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14141

Proposal Category: SNAP  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14141  
Program Title: NGSL Extension 1. Hot Stars and Evolved Stars

Principal Investigator: Guy Worthey

PI Institution: Washington State University

Stars important for the oldest and youngest stellar populations are added to the NGSL library of low resolution stellar spectra. Star categories include Post-AGB stars (planetary nebula central objects and bright nascent white dwarfs), helium burning stars (a sequence including extreme horizontal branch (HB), blue HB, and some cooler HB stars), and normal O main sequence and supergiants (missing from the NGSL).

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14142

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14142  
Program Title: Direct Test of the Brown Dwarf Evolutionary Models Through Secondary Eclipse Spectroscopy of LHS 6343  
  
Principal Investigator: Loic Albert  
  
PI Institution: Universite de Montreal

As the number of field Brown Dwarfs counts in the thousands, interpreting their physical parameters (mass, temperature, radius, luminosity, age, metallicity) relies as heavily as ever on atmosphere and evolutionary models. Fortunately, models are largely successful in explaining observations (colors, spectral types, luminosity), so they appear well calibrated in a relative sense. However, an absolute model-independent calibration is still lacking. Eclipsing BDs systems are a unique laboratory in this respect but until recently only one such system was known, 2M0535-05 -- a very young (<3 Myr) binary Brown Dwarfs showing a peculiar temperature reversal (Stassun et al. 2006). Due to its young age, 2M0535-05 is an ill-suited test for Gyr-old field Brown Dwarfs whose population is by far the most common in the solar neighborhood. Recently, a second system -- an evolved BD (>1 Gyr) -- was identified (62.1+/-1.2 MJup, 0.783+/-0.011 RJup) transiting LHS6343 with a 12.7-day period. We propose to use WFC3 in drift scan mode and 5 HST orbits to determine the spectral type (a proxy for temperature) as well as the near-infrared luminosity of this brown dwarf. We conducted simulations that predict a signal-to-noise ratio ranging between 10 and 30 per resolution element in the peaks of the spectrum. These measurements, coupled with existing luminosity measurements with Spitzer at 3.6 and 4.5 microns, will allow us to trace the spectral energy distribution of the Brown Dwarf and directly calculate its blackbody temperature. It will be the first field Brown Dwarfs with simultaneous measurements of its radius, mass, luminosity and temperature all measured independently of models.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14143

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14143  
Program Title: Probing the nature and evolution of the oldest known planetary system through Lyman-alpha observations  
Principal Investigator: Vincent Bourrier  
PI Institution: Observatoire de Geneve

Five planets smaller than the Earth were recently detected at close orbital distances in the oldest known planetary system, Kepler-444. Their inward migration from larger separations implies that these planets may have accreted large envelopes of molecular hydrogen or water during their formation. Later-on, stellar irradiation would have led to the photodissociation of this envelope, and the formation of a large, extended atmosphere of atomic hydrogen flowing beyond the Roche lobe. We estimate that the two outer and largest planets (Kepler 444 'e' and 'f') would not have completely lost their hydrogen envelop over the system lifetime, and that signatures of atmospheric escape could be detected with HST/STIS at Lyman-alpha with high significance levels (S/N=6 to 30). A bright and close star ( $V=8.9$ ;  $d=35.7$  pc), Kepler-444 has also a high proper motion ( $\gamma=-120$  km/s) that will allow for the first time to probe the entire blue wing and the core of the Lyman-alpha line, where absorption arises from the expanding flow of hydrogen in the thermosphere of the planets. Small planets show a large diversity in nature and composition, which can only be investigated through observations of their atmosphere. No such observations have ever been made for planets as old and small as the sub-Earths of the Kepler-444 system. Given the shallowness of their transit, the only part of their atmospheres that can be observed is an extended atmosphere of hydrogen.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14144

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14144  
Program Title: An Ultraviolet View of Overluminous Type Ia Supernovae

Principal Investigator: Peter Brown

PI Institution: Texas A & M University

Type Ia supernova (SNe) are important cosmological tools because of their standardizable luminosities in the optical and near-infrared. Ultraviolet (UV) wavelengths, however, show a great diversity even in normal objects. Though all SNe Ia are UV-faint, a small and heterogeneous group of SNe have UV luminosities ten times larger than the brightest "normal" SNe Ia. We refer to these as UV-bright, even though the spectral energy distribution still peaks in the optical. The origin of this UV flux is uncertain but could result from hotter explosions (with reduced line opacities) or interaction with a companion star or the circumstellar medium. While evidence of such would be important for understanding these standard candles, these scenarios cannot be distinguished by UV photometry alone. We propose to follow up a UV-bright SN Ia (to be identified by Swift/UVOT observations) with HST/STIS to obtain high quality UV spectra near peak brightness. We will use the HST spectra to search for a hot thermal component arising from ejecta-companion or ejecta-CSM interaction. If the UV excess is not caused by a thermal component, the HST spectra can be used to model the elements responsible for the excess UV emission (or lack of absorption). The origin of the UV flux is key to understanding the progenitor star, companion, local environment, or the explosion. The time to understand the physics behind the UV luminosity is now with Swift/UVOT and HST.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14145

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14145  
Program Title: Characterizing Circumgalactic Gas around Passive Galaxies

Principal Investigator: Hsiao-Wen Chen

PI Institution: University of Chicago

Luminous Red Galaxies (LRGs) are passive galaxies found in dark matter halos of  $\sim 1E13$  Msun with little to no on-going star formation detected. Our group noted in 2009 that a significant fraction of LRGs at  $z \sim 0.5$  display coincident strong MgII absorbers in their halos. This finding is now confirmed with a new and larger sample of LRGs available from SDSS DR12. The presence of cool gas in these massive halos challenges predictions from both numerical simulations and analytic models that halo gas around massive galaxies is hot ( $T > 1E6$  K) and cold clumps would evaporate quickly. The quiescent state of the galaxy also makes starburst outflows an unlikely explanation for the observed MgII absorbers. However, direct and quantitative comparisons with theoretical predictions require knowledge of HI column density and metallicity. To determine these quantities at  $z \sim 0.5$ , FUV spectra of the QSOs are necessary. We have searched SDSS and GALEX archives and found a total of 9 LRGs with a UV bright QSO ( $FUV < 18.5$  mag) at projected distances  $< 150$  kpc. This close LRG-QSO pair sample offers a unique and important opportunity to gain a deeper understanding of halo gas content around LRGs. Four of the QSOs have COS spectra already available in the HST archive, and an initial analysis of the data indicates a modest scatter in the physical properties. Here we propose to obtain high-resolution COS G130M and G160M spectra for the remaining five QSO. The proposed and archival COS spectra together will enable a detailed study of the ionization state and metallicity of halo gas around quiescent galaxies, and offer key insights into the physical origin of cool gas in massive halos.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14146

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14146  
Program Title: Light Echoes and Environment of SN 2014J in M82

Principal Investigator: Arlin Crotts

PI Institution: Columbia University in the City of New York

Type Ia SN 2014J exploded in the nearby M82 = NGC 3032, reaching V maximum light around 2014 February 5, the closest SN since 1987 and likely the closest SN Ia since 1885. Recent HST/WFC3 imaging (2014 September 5 and 2015 February 2) of M82 in the vicinity of SN 2014J reveals a light echo at radius 0.6 arcsec from SN 2014J (or 13 pc in M82), meaning a z distance of 330 pc closer to Earth than the SN. Additional echoes reside at a smaller radii of about 0.3-0.4 arcsec (or z = 80-160 pc). HST observations of SN 2014J's echoes over the next few years will allow us to map and explore further star formation in M82, and the 3-D structure of gas and dust. Echoes in the near future might also reveal circumstellar structure around SN 2014J's progenitor star. This offers us a unique opportunity to study the environment of SNe Ia, here at a level of detail several times better than any other, farther SN Ia observed by HST. M82 is a special galaxy in terms of star formation activity, and SN 2014J offers a special probe of this galaxy since it is a Ia, not core collapse SN, so more likely to sample the structure of M82 more typically, rather than centered on a region recently producing massive stars, such as a core-collapse progenitor. We describe how the light echo mapping that will be provided by the proposed observations will produce a high-resolution, three-dimensional view of a large part of M82, and how this can be directly compared to models of the interstellar medium to learn how star formation feeds back into the gaseous structure of galaxies. This comparison is arguably only possible with SN light echoes, with SN 2014J providing the most useful Ia example.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14147

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14147  
Program Title: Opening a New Window towards the Nuclear Star Cluster in the Milky Way

Principal Investigator: Hui Dong

PI Institution: Instituto de Astrofísica de Andalucía (IAA)

The nuclear star cluster in the Galactic Centre is the only place where we can study star formation near a massive black hole in great detail. However, due to the strong foreground extinction, previous studies have been limited to the J-band and longer wavelengths. The short wavelength coverage, from J to K, hampers attempts to accurately determine the extinction curve, to map the extinction distribution, to distinguish between massive and low-mass stars and finally, to disentangle different stellar populations through the colour magnitude diagram. Deep F105W observations with HST WFC3/IR would result in great progress toward overcoming these problems. This program can help us to make significant progress in addressing the following important astrophysics questions: 1) what are the properties of the extinction law toward the Galactic Centre environment? 2) what was the assembly history of the nuclear star cluster in the Galactic Centre?

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14148

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14148  
Program Title: Near-IR Imaging of Three Spectacular Lensed Submillimeter Galaxies Discovered by the Herschel Lensing Survey  
Principal Investigator: Eiichi Egami  
PI Institution: University of Arizona

One of the most remarkable Herschel results is the discovery of exceptionally bright gravitationally lensed submillimeter galaxies (SMGs). The great sensitivity and mapping speed of SPIRE on Herschel have enabled us to find these rare ( $< 1$  per square degree) extraordinary objects in large numbers. Here, we propose to conduct near-IR imaging of three spectacular lensed SMGs at  $z=2.04$ , 4.69, and 5.24 discovered by our Herschel Lensing Survey (HLS; PI: Egami), which has imaged a total of 581 massive galaxy cluster fields. High-resolution dust-continuum and CO/[CII] line maps we have obtained with SMA, PdBI, JVLA revealed complicated internal structures, allowing us to probe the properties of star-forming regions on the sub-kpc scale. What is missing, however, is the information on the underlying stellar population. We will fill this gap by obtaining WFC3/IR images and mapping out the spatial distribution of the underlying stellar population as well as the amount of dust extinction it suffers.

We will soon receive ALMA data for two of these SMGs with a spatial resolution of 0.2", and the third galaxy already has PdBI maps with a spatial resolution of 0.3" (this galaxy is too north for ALMA to observe). The  $\sim 0.15''$  resolution provided by WFC3/IR nicely matches these resolutions, and can produce a source-plane spatial resolution of  $< 100$  pc when the lensing magnification is taken into account. Such a combination of HST/WFC3 images and high-resolution submillimeter/millimeter maps will open up a new frontier in the study of vigorously star-forming dust-obscured galaxies at high redshift, allowing us to probe the physical properties of star-forming regions individually.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14149

Proposal Category: SNAP  
Scientific Category: Resolved Stellar Populations  
ID: 14149  
Program Title: Continuing a Snapshot Survey of the Sites of Recent, Nearby Supernovae

Principal Investigator: Alex Filippenko

PI Institution: University of California - Berkeley

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

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14150

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14150  
Program Title: Searching for the disappearance of the progenitor of the unique SN 2009ip

Principal Investigator: Morgan Fraser

PI Institution: University of Cambridge

We request HST time in order to obtain late-time imaging of SN 2009ip, where for the first time in the history of astronomy we have monitored a star for many years before it has (possibly) exploded as a supernova (SN). SN 2009ip was first discovered as a giant outburst of a luminous blue variable star in 2009, and three years later an explosive event caused it to reach SN-like luminosities of  $M_V \sim -18$ , and a bolometric luminosity of  $10E43$  erg/s. We have monitored SN 2009ip extensively over the following 2.5 years, and now seek to conduct the definitive test of whether SN 2009ip exploded as a core-collapse supernova or not, by observing whether SN 2009ip fades below or remains above the progenitor magnitude.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14151

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14151  
Program Title: Constraining Pop III supernova energies and the formation of the first low-mass stars with the iron-poor star HE1327-2326 (with  $[\text{Fe}/\text{H}] = -5.4$ )  
Principal Investigator: Anna Frebel  
PI Institution: Massachusetts Institute of Technology

The nucleosynthetic signatures of the first stars and supernovae are imprinted in the atmosphere of the long-lived, iron-poor star HE1327-2326 (with  $[\text{Fe}/\text{H}] = -5.4$ ). Comparing the abundance signatures of stars like HE1327-2326 with predictions of early low-mass star formation pathways as well as low-metallicity supernova yields provides the only empirical constraints on these early processes, including the properties of the first stars (e.g. mass, explosion energy). We propose COS high-resolution near-UV spectral observations of HE1327-2326, which is the only known member of the most iron-poor class of stars bright enough for HST observations. It thus provides us with a unique opportunity for a new abundance analysis to address the important and still unanswered questions about the deaths of Pop III stars and the formation of the first low-mass stars. Using the three COS stripes covering spectral portions between 2120Å and 2350Å, our specific goals are: (1) attempt a Si I detection to rule out that HE1327-2326 formed from dust-cooled gas; (2) attempt a Zn I detection at the level of  $[\text{Zn}/\text{Fe}] \sim 0.5$ . Such a detection would indicate a more energetic Pop III hypernova as progenitor. A non-detection (=lower upper limit) would provide additional evidence of the previously suggested faint, low-energy progenitor; (3) Fe II, Ni I and Ni II lines will be detected and enable detailed iron-peak element nucleosynthesis assesment in the first stars ii) calibration of our UV abundance scale, and iii) assessment of NLTE effects at this low metallicity and a surface gravity measurement. This will yield the kind of robust iron-peak pattern necessary for constraining the PopIII progenitor.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14152

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14152  
Program Title: Hot gas cooling and turbulence in the 3C326N radio-galaxy

Principal Investigator: Pierre Guillard

PI Institution: CNRS, Institut d'Astrophysique de Paris

The 3C326N radio-galaxy is one of the best examples of negative AGN feedback: with  $2e9$  Msun of molecular gas, its star formation rate is below  $0.07$  Msun/year, 20 times lower than what the Kennicutt law predicts. Why there is so much of molecular gas and why it is not forming stars? Powerful mid-IR H<sub>2</sub> emission and very broad optical and far-IR lines suggest that strong turbulence may heat the H<sub>2</sub> gas and prevent it from being gravitationally bound at all scales. The turbulence driven at large scales by the radio jet would cascade down to smaller scales where it is dissipated. It must be powerful enough to drive high-speed shocks (100-400 km/s) in the hot ( $1e7$  K) plasma that will compress it and allows it to cool down to temperatures where the gas becomes molecular. This cooling is expected to occur through UV line emission, and especially through CIV and OVI lines. To test this prediction, we propose to observe those lines in the 3C326N radio-galaxy. This will allow us to: (1) determine whether UV line emission is a significant cooling process of the hot gas, compute the mass cooling rate of the hot gas (is it high enough to form the H<sub>2</sub> disk?), and (2) test our model of the multiphase turbulent gas energized by a radio-jet which would account for both H<sub>2</sub> masses and energetics (can turbulence be sustained by shocks pressurizing the disk?). These observations will greatly enhance our understanding of why 3C~326N, and massive early-type galaxies in general, have large masses of molecular gas but yet weak star formation. The physics explored in this proposal applies to a wide range of environments, including cluster cooling flows and hot gas cooling in haloes of galaxies.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14153

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14153  
Program Title: Measuring the Mass of El Gordo to Near the Virial Radius

Principal Investigator: John Hughes

PI Institution: Rutgers the State University of New Jersey

We propose a wide-area weak gravitational lensing study of ACT J0102-4915 "El Gordo," the hottest, most massive, X-ray luminous, and brightest Sunyaev-Zel'dovich effect cluster and the only bullet-like merging cluster known at redshifts beyond 0.6. Our proposed ACS/WFC/F606W observations will result in a definitive, unbiased, model-independent mass profile to near the virial radius and an internal structure map of this  $z=0.87$  merging cluster to strengthen the constraints its existence places on the growth of structure and the nature of dark matter in the standard cosmological model.



Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14154

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14154  
Program Title: First imaging polarization study of Fomalhaut's 140 AU dust belt

Principal Investigator: Paul Kalas

PI Institution: University of California - Berkeley

As one of the nearest exoplanetary systems with multiple dust structures and a candidate extrasolar planet on a highly eccentric orbit, Fomalhaut draws significant attention from observers and theorists alike. However, there is an unresolved debate concerning the fundamental 3D geometry of the system. This strongly impacts our knowledge of grain properties, such as the size distribution, and the question of spin-orbit alignment between the star, the dust belt, and Fomalhaut b. Here we propose the first optical polarization study of Fomalhaut's 140 AU dust belt, which is made feasible by the high-contrast, diffraction-limited imaging capability of ACS/WFC. As demonstrated with another dust belt system, HR 4796A, determining the Stokes parameters is a crucial diagnostic for scattering geometry and dust grain properties. Measuring the grain optical properties through polarization will not only resolve the spin-orbit debate for Fomalhaut, it will also permit a quantitative comparison to other dusty systems, from the primitive porous aggregates that comprise AU Mic's debris disk, to the highly processed interplanetary dust particles in our own solar system.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14155

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14155  
Program Title: Using Stellar Evolution as a Clock to Watch the Dynamical Evolution of a Globular Cluster  
  
Principal Investigator: Jason Kalirai  
  
PI Institution: Space Telescope Science Institute

We propose a 5 orbit HST program to acquire UV imaging at the center of the massive globular cluster NGC 362, in order to directly measure the rate of diffusion of stars through its core. This measurement will overcome a major observational barrier; that the dynamical time scale for two-body relaxation in the core of a globular cluster is typically much shorter than the age of the population, and so mass segregation in the cluster occurred billions of years ago. Our novel technique aims to resolve this dynamical evolution by using the full power of WFC3's exquisite UV sensitivity at  $<0.3$  microns combined with its high spatial resolution. We will uncover  $\sim 1000$  newly formed stellar remnants - white dwarfs - in the center of the globular cluster and track how their spatial distribution changes as they get "older" on the cooling sequence. Having just experienced a significant episode of mass loss, the youngest white dwarfs with ages  $<10$ s of Myr will still be moving slowly like their  $0.8 M_{\text{sun}}$  progenitors, whereas the "older" white dwarfs that have been cooling for  $>100$ s of Myr will be fully relaxed. To "watch" this dynamical evolution and directly measure the diffusion coefficient, we have selected the very populous globular cluster NGC 362. The cluster is nearby with low reddening, has moderate concentration, and has a theoretical expected relaxation timescale of 60 Myr in its core, perfect to split the young and old white dwarfs that we can observe with Hubble.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14156

Proposal Category: GO  
Scientific Category: Unresolved Star Formation  
ID: 14156  
Program Title: An Ionizing Photon Rate Map of NGC 6946

Principal Investigator: Adam Leroy

PI Institution: The Ohio State University

Significant progress in our understanding of star formation and galaxy evolution depends on ability to obtain precise measurements of the star formation rate on scales from individual regions to large samples of galaxies. In order to do so we need to benchmark star formation rate estimators available for large samples and over wide areas (e.g., H $\alpha$  +IR,

UV+IR) against high quality, spatially resolved "ground-truth" measurements. This has been done in groundbreaking studies for individual regions, but has yet to be done carefully using maps covering whole area of nearby galaxies.

The Paschen beta line is ideal for this purpose: it tracks star formation by tracing ionizing photons that can be cleanly associated with young stars and it is 3x less affected by extinction than the commonly used H $\alpha$  line. Most important WFC3 has the demonstrated ability to map Paschen beta at high resolution and excellent sensitivity over the whole area of nearby galaxies. We propose to use this capability to map the active area of active star formation in NGC6946, making only the second deeply sensitive map of Paschen beta across a whole nearby star-forming galaxy. We will use this to (1) inter-compare proposed ground-truth tracers (free-free, optical Balmer decrement, Paschen beta + H $\alpha$ ) and (2) to improve the calibration of empirical star formation rate estimators by measuring them for individual regions, across large parts of galaxies, and comparing galaxies. Only HST can provide this new and important measurement of an extinction robust tracer of ionizing photon rates at high sensitivity and resolution across a whole galaxy.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14157

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14157  
Program Title: Testing Model Atmospheres with the Coldest Known Brown Dwarf

Principal Investigator: Kevin Luhman

PI Institution: The Pennsylvania State University

Last year, we discovered a brown dwarf, WISE 0855-0714, that has a distance of 2.3 pc and a temperature of ~250 K, making it the 4th closest neighbor of the Sun and the coldest known brown dwarf. Because of its extreme proximity and temperature, it represents an unparalleled laboratory for studying planet-like atmospheres in an unexplored temperature regime. In Cycle 22, we obtained images of WISE 0855-0714 in the single most sensitive band of WFC3 for brown dwarfs (F110W) to assess the feasibility of spectroscopy and multi-band photometry, and to begin using it to test the colors predicted by model atmospheres. We have detected WISE 0855-0714 in those data, and the resulting photometry indicates that it is too faint for spectroscopy, but that photometry in additional HST bands is feasible. Therefore, we propose to observe WISE 0855-0714 with ACS and WFC3 in three bands that are well-suited for testing and discriminating between competing models of very cold atmospheres.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14158

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14158  
Program Title: Mapping the kpc-scale Velocity Structure of Jets with HST

Principal Investigator: Eileen Meyer

PI Institution: Space Telescope Science Institute

HST has recently broken new ground in mapping the velocity profiles of resolved, kpc-scale relativistic jets in nearby active galaxies. While we have long known that the plasma in these jets exhibit highly relativistic speeds on parsec-scales near to the black hole from radio interferometry, it was not known how the jet evolved on kpc to Mpc scales, where the jet leaves the host galaxy and begins to interact with the intergalactic medium, with implications for our understanding of jet structure and quantifying the energy carried by the jet into the external environment. Our group has developed state-of-the-art astrometry techniques to register images of nearby jets taken with HST over the last 20 years to extremely high precision, reaching accuracies on proper motions of better than 0.3 mas/year. First results from a pilot program in Cycle 21 include the dramatic finding of colliding superluminal knots in the jet of 3C264 (Meyer et al. 2015, Nature). We propose moderately deep ACS/WFC imaging of the remaining seven jets which were first observed by HST in the 1990s and which are near enough to yield proper motion accuracies of 0.3-1c. These observations will give us a reference epoch against which to register images extending back over 20 years in the HST archive. The final sample of 11 jets with high-precision kpc-scale velocity measurements will be the only sample of its kind, and will allow us for the first time to begin understanding the evolution of velocity structure on kpc scales, and the connection to jet power and morphology.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14159

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14159  
Program Title: Monitoring an Internal Shock Collision in Action in 3C 264

Principal Investigator: Eileen Meyer

PI Institution: Space Telescope Science Institute

3C264 is a nearby radio galaxy with a prominent optical jet. Recent HST observations (May 2014) have revealed not only the fastest-ever superluminal speed (on kpc scales) of  $7c$  for knot B, but also that knot B is in the very early stages of a collision with slow-moving downstream knot C (Meyer et al. 2015, Nature). This remarkable discovery represents the first strong evidence for the "internal shock" model for particle acceleration, a mechanism proposed to explain sources as diverse as gamma-ray bursts, microquasars, and jetted AGN. While a popular theoretical framework, such a collision has never actually been observed directly in any astrophysical object. Our recent HST imaging has captured the collision in its incipient stages, thus we have a unique opportunity to monitor a major shock collision as it unfolds. We propose 2 epochs of WFC3/UVIS (near-UV, B, and I band) imaging to monitor the optical-UV spectral energy distribution for the colliding knots and continue spatial proper motion measurements of the jet over the next 2-3 years. We also request 1 orbit of polarimetry in F555W with ACS/WFC in each epoch to monitor the polarization structure in the jet for changes as a result of the collision. The collision is expected to manifest in brightening and hardening of the optical spectrum and increasing polarization over the next several years, and our observations will allow us to evaluate the applicability, efficiency and physical characterization of the internal shock mechanism.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14160

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14160  
Program Title: A 100 million-fold increase in the measured sizes of neutral gas reservoirs in the early Universe  
Principal Investigator: John O'Meara  
PI Institution: Saint Michaels College

The damped Lyman alpha systems (DLAs,  $\log(N_{\text{HI}}) \geq 20.3$ ) seen in absorption toward distant quasars have been studied for over 40 years, yet two of their most fundamental properties, namely their size and their mass, have remained elusive. Sightlines to QSOs probe only a fraction of a parsec of the area of the DLAs. Although methods currently exist to measure DLA spatial extents, they trace only their star forming regions (direct imaging), only their rest frame optical extents (IFU searches), or offer only pencil beam piece-wise sampling (close background quasar pair spectra). In this proposal, we present a new technique to directly constrain the size of the neutral hydrogen gas absorption in the DLA via their detection in the spectra of background galaxies. We have a pilot sample of 3 DLAs seen in the spectra of  $z \sim 3$  galaxies, and require HST+WFC3 images to obtain the spatial extent of these galaxies. Doing so will increase our knowledge of the spatial extent of DLA gas by a factor of at least  $10^8$  over present measures.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14161

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14161  
Program Title: The Intersection of Atomic Physics and Astrophysics: Identifying UV Fe I Lines from Metal-Poor Turnoff Stars  
  
Principal Investigator: Ruth Peterson  
  
PI Institution: SETI Institute

Observational surveys are expanding, recording ever-fainter sources from the ultraviolet to the infrared. Needed to characterize them are observational ultraviolet templates at high spectral resolution and low metallicity for the oldest populations, and the laboratory astrophysics data essential to model objects such as stars and nebulae at all ages, metallicities, and redshifts.

We address this by proposing to complete the high-resolution UV spectral coverage of five key metal-poor turnoff stars. These are ideal as metal-poor templates of old stars and as the "laboratory source" for the identification of the thousands of lines of neutral iron that appear in stellar spectra, but are absent from or not identified in laboratory spectra. By matching existing stellar spectra to calculations of energy levels, line wavelengths, and gf-values, Peterson & Kurucz (2015) identified 66 Fe I levels with energies up to 8.4eV, yielding 2000 new lines from 1600 Angstroms to 5.4 microns, and empirical gf-values for 640 of these. The proposed work should yield ~500 new levels and ~10,000 new Fe I lines.

The new energy levels and line parameters also will be posted on the Kurucz website. The new spectra, and supporting theoretical calculations, will be integrated into the publicly available HST Advanced Spectral Library (ASTRAL) Treasury Project. This will leverage the utility of these archival spectral templates and atlases in such diverse areas as nucleosynthesis at early epochs, infrared analysis of dust-obscured giants, reconstructing the populations of nearby globular clusters and dwarf galaxies from their integrated light, and deriving age and metallicity for old, distant galaxies.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14162

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14162  
Program Title: The magnetic activity puzzle of the super-earth host star KOI-314

Principal Investigator: Katja Poppenhaeger

PI Institution: Smithsonian Institution Astrophysical Observatory

Magnetic activity is an ubiquitous phenomenon of cool stars and causes stellar high-energy emission, which is thought to be the driver of atmospheric evaporation of exoplanets in close orbits around their host stars. We have recently observed the super-earth hosting star KOI-314 in X-rays, in order to characterize the evaporation and evolution of its planets. However, we found the star to be very X-ray dim, indicating very low magnetic activity. This is in direct contrast with archival NUV observations with GALEX and optical high-resolution spectra, which show strong magnetic activity in the upper and lower chromosphere. We propose to obtain a new NUV spectrum with the WFC3/UVIS UV grism in one HST orbit in order to characterize the current activity level in the upper chromosphere, and compare this to current X-ray measurements of the coronal activity and optical spectra of the lower chromosphere activity. Investigating this stellar atmosphere that seems to deviate from the usual coronal and chromospheric heating standard model is relevant for understanding the high-energy environment and evolution of exoplanetary atmospheres.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14163

Proposal Category: SNAP  
Scientific Category: Cosmology  
ID: 14163  
Program Title: Honing Type Ia Supernovae as Distance Indicators, Exploiting Environmental Bias for  $H_0$  and  $w$ .  
Principal Investigator: Mickael Rigault  
PI Institution: Humboldt Universitat zu Berlin

Type Ia supernovae are excellent distance indicators and provide a unique probe for measuring the expansion history of the Universe. They play key roles both in measuring the Hubble Constant,  $H_0$ , and the dark energy equation of state,  $w$ . However their exact nature remains uncertain and astrophysical dependencies have been identified and shown to significantly affect the measurements of  $H_0$  and  $w$ . Recently we have used a unique sample having local host information to demonstrate that, far from being a problem, correlations between standardized SN Ia brightnesses and properties of their local environment can be used to improve SNe Ia as distance indicators. These correlations can be used to both reduce the dispersion in standardized brightnesses and correct existing biases.

This proposal aims to analyze both global and local properties using UV-to-optical photometry in order to understand the source of the SN astrophysical biases found so far, and to use that knowledge to develop tools with which future high-redshift SN Ia surveys can correct or exploit these correlations. The UV data necessary to break the degeneracy between stellar ages and dust extinction is only accessible from space, and in the UV, only HST can provide the angular resolution necessary to study the

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14164

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14164  
Program Title: Exploring the nature and synchronicity of early cluster formation in the Local Group

Principal Investigator: Ata Sarajedini

PI Institution: University of Florida

Globular clusters (GCs) are fossil relics from which we can obtain critical insights into star formation processes at very early epochs and the growth of galaxies over cosmological time. It has recently become clear that Galactic GCs are complex systems harboring multiple stellar populations with a variety of unexpected characteristics, posing severe difficulties for conventional formation models. Moreover, precision photometry from HST has enabled accurate relative age measurements for a large sample of Galactic GCs, revealing the presence of tight correlations in age-metallicity space that are difficult to explain in the canonical two-phase picture for the assembly of the GC system. We propose a new angle of attack on both these problems by conducting deep UV-optical imaging of old GCs in the Large Magellanic Cloud - one of our nearest neighbors and a representative of the class of dwarf galaxies usually assumed to be the "building blocks" of larger galaxies in LCDM cosmology. We will conduct the first thorough photometric characterisation of multiple populations in any extragalactic GCs, allowing us to begin assessing the universality of the multi-population phenomenon and its environmental dependence. Furthermore, the cluster main sequence turn-offs will be delineated with unprecedented clarity, facilitating the most precise comparison ever made between the ages of Galactic and external GCs. This constitutes arguably the most sensitive available test of the synchronicity of early star formation across the Local Group. As a bonus, we will be able to determine the distance to the LMC to a few percent accuracy using the method of subdwarf fitting.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14165

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14165  
Program Title: Revealing the largest gravitational lens PLCK G287.0+32.9

Principal Investigator: Stella Seitz

PI Institution: Universitats-Sternwarte Munchen

We propose to investigate the peculiar and extremely large gravitational lens PLCK G287.0+32.9, discovered as one of the most massive objects in SZ measurements by Planck. Our follow-up of the cluster with optical WFI ground based imaging shows evident strong lensing features in the cluster core. The outer arcs, confirmed at  $z=1.167$  from our recent VIMOS observations, is at a distance of  $\sim 85''$  from the brightest and centrally located galaxy of the cluster, which makes PLCK G287.0+32.9 a candidate for the largest strong lens in the sky. If confirmed, this would significantly add to the tension of observed Einstein radii with predictions from Lambda-CDM. To this end, we require high resolution spatial imaging of the cluster to verify its large lensing features and further investigate its properties. Our goal is to use the HST photometry with our recent VLT/VIMOS spectroscopic datasets to perform a robust and detailed strong lensing analysis of this cluster. We aim to trace the total mass distribution of PLCK G287.0+32.9 by combining the strong lensing features with our WFI weak lensing analysis.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14166

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14166  
Program Title: Whimper of a Bang: Documenting the Final Days of the Nearby Type Ia Supernova 2011fe  
  
Principal Investigator: Benjamin Shappee  
  
PI Institution: Carnegie Institution of Washington

Even though SNe Ia are crucial to cosmological studies as distance indicators, the exact nature of these systems remains theoretically ambiguous and observationally elusive. However, there is a new hope. The very late-time lightcurves of SNe Ia harbor important clues to the natures of their progenitor systems. First, the ejecta from the SN will shock heat a non-degenerate companion, leaving it luminous and visible at very late times after the SN has faded. Second, due to nucleosynthetic effects during explosion, single and double degenerate SNe Ia models are predicted to produce vastly differing amounts of  $^{57}\text{Co}$  and  $^{55}\text{Fe}$ .  $^{57}\text{Co}$  and  $^{55}\text{Fe}$  dominate the power of the very late time light curves of SNe Ia after  $>1050$  days after the initial explosion. Broadband observations of the bolometric luminosity at these epochs have the ability to measure the ratio of these two isotopes and thus discriminate between progenitor models. As the brightest SN Ia in nearly 40 years, SN 2011fe offers a prime opportunity to follow a SN Ia to such late epochs. Here we propose HST WFC3 optical and IR photometry of SN 2011fe to observe the transition from a  $^{56}\text{Co}$  to a  $^{57}\text{Co}$  powered lightcurve and to constrain a possible shock-heated companion. These observations will place unique constraints on progenitor systems of SNe Ia. SN 2011fe, having been already observed for more than 1300 days and a factor of a million in flux, is likely to remain the best studied normal SN Ia of our generation and if these observations are not made this cycle, they will likely never be done with Hubble.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14167

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14167  
Program Title: Draining the Local Void

Principal Investigator: Edward Shaya

PI Institution: University of Maryland

From the theory of the growth of structure it is anticipated that material rushes away from the centers of voids at velocities that depend on the cosmological parameters  $\Omega_m$  and  $H_0$ , how empty the void is, and the radius from the center. If dark energy has a variable equation of state it may pool in voids and add to outflow velocities. The Local Group resides on the boundary of the very large Local Void and it has been determined that we have a peculiar motion of 260 km/s away from the void. Though the Local Void is mostly empty, it does contain a few lonely galaxies. For those that are nearby, accurate distances can be determined from resolved images through identification of the Tip of the Red Giant Branch. Accurate distances allow the determination of accurate peculiar velocities. Serendipidously, one galaxy in the void has been studied and it has a peculiar velocity of 300 km/s away from the void center. An Arecibo Telescope survey recently discovered an excellent target in the Local Void. This interesting galaxy will be studied with this program to affirm if void galaxies systematically have large velocities of expansion from the void center and, incidentally, to investigate the star formation and metallicity properties of this isolated galaxy. The important void expansion test of the theory of the formation of large scale structure can only be made locally, where peculiar velocities dominate Hubble velocities. It is fortuitous that we live adjacent a very large void.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14168

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14168  
Program Title: COS Views of He II Emitting Star Forming Galaxies: Preparing for the JWST Era

Principal Investigator: Daniel Stark

PI Institution: University of Arizona

Over the last year, our first glimpse of the spectral properties of  $z \sim 7$  galaxies has emerged. Deep UV spectra have revealed very prominent emission from nebular CIII] and CIV, pointing to an extreme radiation field in reionization-era systems. This is a significant departure from typical galaxy spectra at  $z \sim 2-3$ . The importance of these UV lines will increase greatly in the near future, as they will likely be the only way we can characterize the spectra of the most distant ( $z > 10$ ) galaxies JWST will be able to detect. Unfortunately we are currently completely unprepared to interpret these features, in large part because UV templates of nearby star forming systems with very hard ionizing spectra are absent. Here we propose to remedy this shortcoming by obtaining COS UV spectra of 10 nearby star forming galaxies that are known to have hard ionizing spectra from their optical spectra. Using the G160M and G185M gratings, we will characterize the strength of four diagnostic UV lines (CIV, He II, OIII], CIII]). The data will provide new insight into the nature of massive stars that power high ionization emission lines, demonstrating whether nearby star forming systems ever produce UV equivalent widths as large as are now being observed at high redshift. The spectra will be used to calibrate the UV spectral models that will become commonplace in the JWST era. If this UV spectral database is not obtained while COS is still operating, there are bound to be large systematic uncertainties in our understanding of the nature of the most distant galaxies that JWST finds.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14169

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14169  
Program Title: Measuring the absolute H<sub>2</sub>O abundance of WASP-39b's atmosphere

Principal Investigator: Hannah Wakeford

PI Institution: University of Exeter

Over the past few years, observations of close-in giant planet atmospheres using WFC3's spectroscopic capabilities have played a pivotal role in the NIR characterization of these worlds. We propose to build upon this success by measuring H<sub>2</sub>O in the atmosphere of the warm Saturn-mass exoplanet WASP-39b. Our previous optical STIS observations have revealed that WASP-39b has a cloud and haze-free atmosphere, implying that a strong H<sub>2</sub>O signal will be detectable. Combined with the scattering signature due to H<sub>2</sub> that we have measured at shorter wavelengths, our detection will enable us to determine the absolute H<sub>2</sub>O abundance of the atmosphere. This information is extremely valuable, as it helps to constrain the formation and evolutionary history of the planet, such as the composition of the primordial accretion disk and the planet's location within that disk. Very few H<sub>2</sub>O abundance measurements for transiting exoplanets are currently available, fewer in which the interpretation is not hindered by clouds or hazes. As such, with a clear atmosphere WASP-39b is uniquely placed to provide an important constraint on its atmospheric chemical abundances.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14170

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14170  
Program Title: A Complete Census: Mapping the Ly $\alpha$  Emission and Stellar Continuum in a Lensed Main-Sequence Galaxy at  $z=2.39$  Hosting an AGN-driven Nuclear Outflow  
Principal Investigator: Eva Wuyts  
PI Institution: Max-Planck-Institut für extraterrestrische Physik

We propose to image the Ly-alpha and stellar continuum emission for an exceptionally bright lensed main-sequence galaxy at  $z=2.39$ . Its chance alignment close to a natural guide star (very rare for arcs in cluster environments) has allowed high signal-to-noise SINFONI+AO observations of all the rest-frame optical diagnostic emission lines ([OIII], H-beta, [OI], H-alpha, [NII] and [SII]). We find an underlying broad component with FWHM~740 km/s in both the Balmer and forbidden lines, and measure line ratios which place the outflow robustly in the region of the BPT diagrams associated with AGN ionisation. At this redshift, Ly-alpha uniquely falls in the F410M WFC3 medium-band filter. With a modest investment of six orbits, we will map the Ly-alpha emission and stellar UV continuum of this source at spatial scales  $\sim <100$  pc - similar resolution to the SINFONI+AO data. This will allow us to compare the spatial extent and morphology (smooth or clumpy) of the Ly-alpha, UV and dust-corrected H-alpha emission and disentangle the effects of star formation and AGN ionisation on each tracer. This is a truly unique opportunity where a combination of gravitational lensing, AO guide star, the right source redshift, and the presence of a weak AGN allow a complete and magnified view of three main tracers of the physical conditions and structure of the interstellar medium in a star-forming galaxy at cosmic noon.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14171

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14171  
Program Title: Characterizing the Circumgalactic Medium of Luminous Red Galaxies

Principal Investigator: Guangtun Zhu

PI Institution: The Johns Hopkins University

We propose to survey the Circumgalactic Medium (CGM) of 15 Luminous Red Galaxies (LRGs) at  $z \sim 0.5$ , drawn from the SDSS-III/Baryon Oscillation Spectroscopic Survey (BOSS). Through the analysis of SDSS quasar spectra lying fortuitously behind LRGs, we have established that these galaxies exhibit significant (even strong) MgII absorption on scales from several tens kpc to more than tens of Mpc (Zhu et al. 2014). The results at  $\sim 100$  kpc, i.e. well within the virial radius of the LRG halos, reveal that these massive, non star-forming galaxies exhibit a cool and enriched CGM that even rivals that for modern,  $L^*$  galaxies. With COS G140L spectroscopy, we will characterize the HI Lyman series and Lyman limit opacity of the LRG CGM at impact parameters  $r_p = 30-400$  kpc (2/3 of the LRG virial radius). These data will constrain the mass of the cool CGM of these massive galaxies and enable estimate of the gas metallicity (especially for the systems that exhibit positive MgII absorption). Furthermore, these spectra will characterize the incidence of strong highly-ionized absorption lines, such as CIII, SIII and OVI. Our results will inform on the processes that influence the origin and evolution of halo gas, e.g. the transition from a primarily cool CGM to a hot, X-ray halo as galaxies gain mass and evolve towards the group and cluster environment.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14172

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14172  
Program Title: Imaging Accreting Protoplanets in the Young Cluster IC 348

Principal Investigator: Brendan Bowler

PI Institution: California Institute of Technology

Giant planets generate accretion luminosity as they form, much of which is radiated in the form of H $\alpha$  line emission at 6563 Ang. We propose a novel survey to identify accreting protoplanets in the young (~2 Myr) cluster IC 348. Our efficient program will target 225 cluster members, offering the first opportunity to study sub-Jovian-mass planets with direct imaging and characterize a population of planets generally inaccessible with ground-based adaptive optics imaging. This survey will clarify the origin of planetary-mass companions on ultra-wide orbits of hundreds of AU by probing masses of ~0.5-5 MJup, which is below the fragmentation limit set by disk instability and cloud fragmentation but should be heavily populated in the case of planet/core scattering. Based on the frequency of massive giant planets at wide separations, we also stand to increase the number of accreting 5-15 MJup companions by ~50%. Finally, these data will have lasting value as a rich resource to study accretion, multiplicity, and the internal kinematics of IC 348.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14173

Proposal Category: GO  
Scientific Category: ISM and Circumstellar Matter  
ID: 14173  
Program Title: A Multiwavelength Study of the Nature of Diffuse Atomic and Molecular Gas

Principal Investigator: Steven Federman

PI Institution: University of Toledo

Our proposed observations under the UV Initiative form a key component of a multiwavelength study of diffuse atomic and molecular clouds. The Herschel GOT C+ survey associated [C II] emission at 158 microns with emission from H I at 21 cm and CO at 2.6 mm, revealing the presence of warm neutral gas, cold neutral gas, CO-dark H<sub>2</sub> gas, and molecular clouds. Ground-based measurements of Ca II, CH<sup>+</sup>, CH, and CN at visible wavelengths show absorption at the same velocities as the components seen in the GOT C+ survey. A main focus of our project is a detailed investigation of the nature of CO-dark H<sub>2</sub> gas, interstellar material not associated with H I and CO emission. The presence of this additional material alters our view of molecular gas in galaxies and its connection to star formation rates. We propose ultraviolet observations of three targets with STIS that probe two of the pointings in the GOT C+ survey. Absorption from CO, at much greater sensitivities than is possible from surveying CO emission, will be sought. Analysis of CO, C I, and C<sub>2</sub> absorption will yield the physical conditions (gas density and temperature) along the sight lines. The results will be compared with those inferred from CN chemistry based on the observations at visible wavelengths. Other probes seen at UV wavelengths, such as O I, Cu II, and Cl I, will provide a more complete picture of the environment seen in the atomic components of the GOT C+ survey. The outcome of the project will be the most detailed study of diffuse atomic and molecular gas from spectral measurements spanning nearly seven orders of magnitude in wavelength.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14174

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14174  
Program Title: Probing Extended Star Formation in the Young Massive Star Cluster NGC 1850

Principal Investigator: Paul Goudfrooij

PI Institution: Space Telescope Science Institute

Recently, deep HST images revealed that several massive intermediate-age star clusters (SCs) in the Magellanic Clouds exhibit extended main-sequence turn-offs (eMSTOs), and in some cases also dual red clumps. This poses serious questions regarding the mechanisms responsible for the formation of SCs and their well-known light-element abundance variations. While many recent studies indicate that the eMSTOs are caused by a range in stellar age of about 100-500 Myr among cluster stars, the obvious and important question is: Why has this not been observed yet in SCs in that age range? Our recent studies suggest that prolonged star formation in SCs requires a cluster escape velocity in excess of about 15 km/s, and young SCs with such high escape velocities are extremely rare in the Local Group. We recently identified a SC in the Large Magellanic Cloud (LMC) that has the right mass and size to be able to retain mass loss in slow winds of the first stellar generation while being young enough to still host some of its second stellar generation (if present) on the pre-main sequence (PMS) and showing emission-line signatures: the ~90 Myr old cluster NGC 1850 in the LMC. Since this SC has no adequate HST imaging to detect an eMSTO or PMS stars associated with the cluster, we propose to obtain deep WFC3/UVIS broad-band imaging with filters F275W and F814W to analyze the MSTO region and use F656N imaging to search for Balmer-line emission signatures from PMS stars of the second stellar generation. The detection of an eMSTO and/or PMS stars in this SC (or a lack thereof) will have a lasting impact on our understanding of the eMSTO phenomenon and of star cluster formation in general.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14175

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14175  
Program Title: Resolving the Nature of the Stellar Halo of the Sombrero, the Nearest Giant Early-Type Spiral Galaxy  
  
Principal Investigator: Paul Goudfrooij  
  
PI Institution: Space Telescope Science Institute

Early-type spiral galaxies lie at the apex of the Hubble sequence of galaxies between spirals and ellipticals, and likely play a key role in the morphological and dynamical evolution of galaxies. At a distance of 9 Mpc, the Sombrero (NGC 4594) is the nearest giant early-type spiral galaxy. As such, it is a keystone object for understanding the evolution and early star formation history of such galaxies.

Metallicity distribution functions (MDFs) of galaxy halos place important constraints on the hierarchical formation and assembly histories of galaxies. We therefore propose to obtain deep V- and I-band imaging of halo fields in the Sombrero galaxy using WFC3 and ACS in parallel to determine MDFs of individual red giant stars, extending in radius from the outer bulge to the limits of the halo. These data will enable us to address fundamental questions regarding early-type spiral galaxy assembly such as: At what galactocentric radius does the metal-poor field star component start dominating the metal-rich one? How do the radial distributions of metal-poor and metal-rich globular cluster subpopulations compare with those of the halo field stars at the same metallicities? What is the number of massive globular clusters per unit field star for populations of different metallicity? Is there a stellar metallicity gradient in the halo? This is the first such study for any early-type spiral galaxy, and it will provide a new window on the early star formation history of such galaxies, providing unique constraints on the hierarchical assembly scenario.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14176

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14176  
Program Title: Measuring Absolute Abundances in NGC 5548 and Definitively Linking the UV and X-ray Outflows  
Principal Investigator: Gerard Kriss  
PI Institution: Space Telescope Science Institute

We propose to obtain HST/COS spectra of the Seyfert 1 galaxy NGC 5548 with 9 orbits covering the Lyman lines, O VI, P V, N V, and C IV in conjunction with 60 ks of XMM-Newton time. Our observations will measure absolute abundances anchored by accurate H I column densities for both the narrow and broad UV absorption lines. These will add fidelity to our measurements of the outflowing mass flux and kinetic energy obtained in our 2013 campaign using XMM-Newton and COS, and solve discrepancies between the UV and X-ray absorbers in NGC 5548. Due to the profound influence of the new soft X-ray obscurer in NGC 5548 discovered during our 2013 campaign, simultaneous X-ray spectra are essential for determining the ionizing spectral energy distribution. Outflows from active galactic nuclei (AGN) may play a crucial role in feedback processes that control galaxy evolution, the growth of central black holes in galaxies, and the chemical enrichment of the surrounding environment. The high throughput and resolution ( $R > 12,000$ ) of COS at wavelengths below 1150 Å make it possible to observe O VI and the Lyman lines in nearby bright AGN and link high-resolution X-ray spectroscopy of O VI and higher ions with longer-wavelength UV observations. Observations of the resonance doublets of O VI, N V, and C IV enable robust photoionization solutions as a function of outflow velocity that include the determination of absolute abundances relative to hydrogen. Observations of unsaturated Lyman lines are the only way to measure hydrogen column densities for absolute abundances. This provides crucial information on the physical conditions in AGN outflows and their chemistry.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14177

Proposal Category: GO  
Scientific Category: Resolved Star Formation  
ID: 14177  
Program Title: Identifying Ionization Mechanisms through Spatially-Resolved Neon Emission in the Jets of Sz 102  
  
Principal Investigator: Chun-Fan Liu  
  
PI Institution: Academia Sinica, Institute of Astronomy and Astrophysics

Understanding how jet and wind are launched from the disk is essential in understanding how gas accretes through the disk and onto the star in a young stellar system. Studying the jet launch region requires sub-AU resolution which is unresolvable with current facilities but emission from the jet helps to probe the physical conditions close to the launch region. Line diagnostic studies of jets from low-mass young stars suggest most of them are partially ionized, yet the origin of ionization is not fully understood. To investigate the relation between the jet and its ionization sources, we propose to obtain spatially-resolved HST/STIS [Ne III] 3869 spectra along the jet of the T Tauri star Sz 102. Neon has high photoionization thresholds and high valence ionization potentials that are most sensitive to high-energy processes in low-mass star formation, especially hard (keV) X-rays and strong (100 km/s) shocks. Its high-density forbidden transition [Ne III] 3869 provides probe close to the jet-driving region. Sz 102 drives bright bipolar jets that emit [Ne III] 3869, and has an edge-on oriented disk which blocks most of the stellar light and permit analysis at high spatial resolution. Hard X-ray irradiation is expected to occur close to the star while strong jet shocks occur further away as the flow propagates outward. By resolving the spatial distribution of the [Ne III] line, we aim to identify the major ionizing source of the Sz 102 jet. The study will help to infer the overall structure of ionization sources and be linked to magnetic structure in the star-disk system, which is responsible for launching the jet, potentially producing jet shocks, and emitting X-ray photons.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14178

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14178  
Program Title: WFC3 Infrared Spectroscopic Parallel Survey: The WISP Deep Fields

Principal Investigator: Matthew Malkan

PI Institution: University of California - Los Angeles

WFC3 Infrared Spectroscopic Parallels (WISPs) exploit HST's unique NIR slitless spectroscopy to measure galaxy evolution from  $0.5 < z < 2.5$ . WISP is particularly sensitive to star-forming galaxies, independent of their mass. WISP finds a large population of dwarf galaxies, with low metallicity, overlooked by continuum-selected surveys. WISP's wide, continuous spectral coverage with the G102 and G141 grisms (0.8-1.7 $\mu$ m) provides the best measurement of the dereddened star formation rates, and the mass-metallicity relations, for galaxies throughout this epoch. We propose to extend this cost-effective WFC3 Survey, emphasizing deeper ( $\geq 6$ -orbit) opportunities, where the current WISP spectroscopy will be more than doubled. Combined with our wider shallower coverage, this will complete a sample of  $\sim 10,000$  galaxies with [OII], [OIII], Ha, Hb, or [SII] emission lines, free from cosmic variance, to achieve several science goals: 1) Derive the extinction-corrected Ha luminosity function, and the cosmic history of star formation across  $0.5 < z < 1.5$ , and the [O III] luminosity function to redshift 2.5. 2) Measure the mass-metallicity relation at  $z > 1$  to very low masses. 3) Determine the role of metal-poor dwarfs and high-sSFR starbursts in galaxy assembly. 4) Use the Balmer break and D4000 absorption to determine the ages of quenched galaxies down to  $J=24-25$ . 5) Search for rare objects such as Ly $\alpha$  emitters at  $z > 6$ , reddened AGN, close spectroscopic pairs of galaxies, gravitationally lensed arcs, and T- and Y-dwarf stars. The WISP value-added public data release is likely to be one of Hubble's major legacies of 0.8-1.7  $\mu$ m spectroscopy, and a key pathfinder for JWST, Euclid and WFIRST surveys.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14181

Proposal Category: SNAP  
Scientific Category: Resolved Star Formation  
ID: 14181  
Program Title: A Snapshot WFC3 IR Survey of Spitzer/Herschel-Identified Protostars in Nearby Molecular Clouds  
  
Principal Investigator: S. Megeath  
  
PI Institution: University of Toledo

We propose a Snapshot survey targeting 312 protostars identified with Spitzer and Herschel in molecular clouds within 420 pc of the Sun, complementing a WFC3/NICMOS survey of the Orion molecular clouds (420 pc). While Spitzer and Herschel can obtain the SEDs of protostars, HST imaging with WFC3 can resolve protostars with spatial resolutions of 100 AU or less, probing the structure of infalling protostellar envelopes through light scattered by dust grains in the envelopes, detecting protostellar disks in absorption, and identifying faint companions to the protostars. This survey will increase significantly the number of protostars imaged at this resolution and will impact several key problems. With these data we can i.) determine the incidence of protostellar multiplicity and the dependence of multiplicity on the birth environment, ii.) assess the role outflows play in halting accretion by the clearing of protostellar envelopes, and iii.) measure the properties of potentially planet forming disks during the protostellar phase. The protostars have been selected from the Spitzer c2d, Gould Belt, Taurus and Orion Surveys. Even if 1/3 of the targets are observed, as expected for a snapshot proposal, this will be 2nd largest, high angular resolution protostar survey to date.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14182

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14182  
Program Title: The Coma Cluster Core Project

Principal Investigator: Thomas Puzia

PI Institution: Pontificia Universidad Catolica de Chile

We propose to use WFC3 to perform a contiguous, high spatial resolution UV (F336W) and IR (F160W) survey of an area of ~100 square arcminutes in the core of the Coma cluster of galaxies. The area is already surveyed by our group in optical passbands with the ACS F475W and F814W filters. The new UV and IR data will be used, in combination with existing ACS data, for studies of the populations of Globular Clusters (GCs), Ultra-Compact Dwarf Galaxies (UCDs), and Nuclear Star Clusters (NSCs) in Coma galaxies and in the cluster environment. Using an innovative technique developed by members of our team, we can essentially eliminate foreground and background contamination from samples of compact stellar systems. This allows us, for the first time, to perform the most detailed assessment and study of the very large population of Intracluster GCs in a nearby rich cluster (i.e. Coma), to find why this population is so abundant, and why it contains such a significant metal-rich component, which is unexpected if the origin is from stripping of clusters from low-mass dwarf galaxies. For NSCs, the additional passbands will allow us to test predictions of the relationship between NSC properties and age and metallicity gradients in the host galaxies, which in turn helps to understand the NSC formation mechanisms, and the timescale and feedback process that truncate the star formation. This is the last opportunity to perform a rest-frame UV survey at  $z=0$ , given the rapidly declining capability of WFC3/UVIS and the fact that there is no prospect for a future UV space mission for decades to come.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14183

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14183  
Program Title: The intermediate-age cluster GLIMPSE-C01

Principal Investigator: Blagoy Rangelov

PI Institution: George Washington University

We propose multi-band HST observations of the most massive intermediate-age star cluster in the Galaxy GLIMPSE-C01. Considering the cluster's age, an unusually large number of X-ray sources has been detected in a previous Chandra program. In addition, extended X-ray emission was detected around GLIMPSE-C01 to spatially coincide with IR emission, indicating an ongoing interaction between the cluster and its environment. There is little information about the X-ray source population in intermediate age clusters. We will investigate the X-ray source population in GLIMPSE-C01 using our multiwavelength classification method to determine the nature of the X-ray sources in the cluster. This will enable us to study the X-ray binary evolution and history of the sources in GLIMPSE-C01. We request only one HST orbit to achieve this goal.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14184

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14184  
Program Title: A Local Benchmark for High-Redshift Feedback

Principal Investigator: David Rupke

PI Institution: Rhodes College

Galactic winds are crucial channels of star formation and AGN feedback at the peak epochs of star formation and black hole activity. However, rest-frame NUV observations of  $z=1-2$  winds, which employ resonant metal lines, are constrained by sensitivity and generally have no spatial resolution. We recently discovered spatially-resolved metal resonant line emission and absorption in a nearby wind in the rest frame optical. We propose to use STIS to observe the same resonant lines used at high  $z$  (in the rest-frame NUV, 2600-2800 Å) but in a low  $z$  wind for the first time. We will use the detailed, 100 pc spatial information that this provides and combine with our current data to uncover the structure and mass loss rates of these winds, and ultimately to provide leverage for understanding the same absorption line signatures at high redshift.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14185

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14185  
Program Title: Imaging the extended star formation in the host galaxy of a millimeter bright quasar at  $z=6.13$   
Principal Investigator: Ran Wang  
PI Institution: KIAA, Peking University

The detections of strong dust continuum, molecular CO, and [C II] emission from quasars at  $z\sim 6$  at millimeter and radio wavelengths provide the first evidence of SMBH-galaxy coevolution in the most distant universe. We here propose HST WFC3/IR J(F125W) and H(F160W) observations to image the UV stellar continuum from the host galaxy of a millimeter bright quasar ULAS J1319+0950 at  $z=6.13$ . We have obtained ALMA high resolution image of the [C II] fine structure line and dust continuum emission from this object, which reveals intense star formation in the central  $\sim 1''$  (5 kpc) region of the quasar host galaxy. The WFC3/IR observations we propose here will map the rest-frame 1500Å~2500Å stellar continuum emission from the starburst quasar host. We will measure the UV-based star formation rate and surface density, and compare the distribution of the UV stellar emission to the resolved [C II] line and dust continuum emission from ALMA. This is an important consistency check of the massive star formation inferred from the millimeter observation and will allow us to map the dust extinction and investigate the relation between star formation rate and the [C II] line emission in the extreme AGN-starburst environment. Moreover, the color measured with the two WFC3/IR bands will constrain the slope of the UV continuum, which is sensitive to the local dust extinction, age, and metallicity of the young quasar host galaxy. These will allow a comprehensive study of the distributed star formation in the earliest quasar host galaxies for the first time and, thus, set key constraints on our models of SMBH-galaxy co-evolution at the earliest epoch.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14186

Proposal Category: GO  
Scientific Category: ISM and Circumstellar Matter  
ID: 14186  
Program Title: Mapping dust extinction properties across the IC 63 photodissociation region

Principal Investigator: Heddy Arab

PI Institution: Space Telescope Science Institute

Dust plays a crucial role in the chemical and dynamical evolution of the ISM. Its physical and chemical properties are however not well constrained. Photo-dissociation regions (PDRs), located at the interface between H II regions and molecular clouds, are ideal objects to study the properties and evolution of dust grains, because physical conditions within them change on very short length scales. In order to determine how the dust extinction parameters vary across a PDR, we propose to map the IC 63 PDR from the UV to the near infrared at high resolution with HST WFC3, similarly to the approach taken in the Panchromatic Hubble Andromeda Treasury (PHAT). These observations will allow us to derive simultaneously stellar (spectral type, effective temperature and luminosity) and extinction parameters ( $A_V$ ,  $R_V$ ) for many background stars behind IC 63. The spectral type will identify prime candidates for followup HST UV/spectroscopy, whereas extinction parameter maps will reveal for the first time the extinction variations across a PDR. We will gain valuable information on how the grain size distribution and optical properties of dust are affected by the strong density gradient and the sharp changes in the physical conditions, such as radiation field, typical of PDRs. The results of this study will bring new constraints on the modeling of dust formation and processing in the ISM. Moreover, this analysis combined with ancillary data from Spitzer and Herschel will give for the first time a complete view of dust within a PDR.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14187

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14187  
Program Title: Studying the nuclear morphology of a dwarf galaxy with a 50,000 solar mass black hole  
Principal Investigator: Vivienne Baldassare  
PI Institution: University of Michigan

Active galactic nuclei in dwarf galaxies represent a new class of objects in which to study the physics of black hole growth and black hole-galaxy coevolution. We recently discovered an active 50,000 solar mass black hole in the nucleus of RGG 118, a dwarf disk galaxy ~100 Mpc away. Here, we propose WFC3/IR and UVIS observations to study the detailed nuclear morphology of the host galaxy. Such systems are still relatively rare compared to the population of active galactic nuclei as a whole, and sensitive, high resolution observations are necessary to determine whether these systems have special structural properties (i.e. bulges, nuclear bars) compared to the general dwarf galaxy population. Additionally, these observations will allow us to measure bulge mass and luminosity to test whether RGG 118 follows well-known black hole-galaxy scaling relations.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14188

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14188  
Program Title: Exometeorology: Characterizing Weather on a Young Free-Floating Planet

Principal Investigator: Beth Biller

PI Institution: University of Edinburgh, Institute for Astronomy

Variability attributed to cloud structure is a persistent feature for L and T type field brown dwarfs. Directly imaged planets occupy the same temperature regime as L and T type brown dwarfs and are likely to be equally variable. As part of our ongoing NTT SOFI survey for variability in young free-floating planets and low mass brown dwarfs, we detect significant variability in a young, free-floating planetary mass object, likely due to rotational modulation of inhomogeneous cloud cover. This is the first such detection in a bonafide planetary mass object -- here we propose for HST and Spitzer followup to pinpoint the source of the observed variability and determine the rotational period of the object. Due to its low surface gravity, while this object has a late L spectral type, it has an "early/mid T"  $T_{\text{eff}} < 1200$  K. We will directly test the effect of low surface gravity on observed variability. If variability matches that found in objects with similar spectral type but higher surface gravity -- i.e. high-level hazes observed in mid L dwarfs by Yang et al. 2015 -- we expect similar variability amplitudes in all bands. If variability is due to inhomogeneous clouds as found in higher gravity T dwarfs with similar  $T_{\text{eff}}$  (Buenzli et al. 2015, Apai et al. 2013), we expect variability to be strongest in broadband J and H and have lower amplitudes within the 1.4  $\mu\text{m}$  water absorption feature (only observable from space). As ground-based searches for brown dwarf variability only have sensitivities to  $>2\text{-}3\%$  variability, we require the proven photometric stability of HST and Spitzer (sensitivity down to  $<0.5\%$  variability) to be sensitive to small differences between bands.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14189

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14189  
Program Title: Quantifying Cold Dark Matter Substructure with a Qualitatively New Gravitational Lens Sample

Principal Investigator: Adam Bolton  
PI Institution: University of Utah

We propose WFC3 UVIS imaging of a new sample of 21 gravitationally lensed Lyman-alpha emitting galaxies (LAEs) discovered within the million-galaxy spectroscopic database of the Baryon Oscillation Spectroscopic Survey (BOSS) of the third Sloan Digital Sky Survey (SDSS-III). These systems consist of massive galaxies at redshifts of approximately 0.55 strongly lensing LAEs at redshifts from 2 to 3. Monte Carlo simulation of our survey selection function indicates that these LAEs will all be strongly lensed and highly magnified. This represents the first statistically significant sample of strong galaxy-galaxy lenses with high-redshift LAEs as their background sources. Viewed in rest-frame far-UV continuum light with WFC3 imaging, these LAEs have much more compact sizes than the lower-redshift lensed galaxies discovered by previous surveys (few 100 parsec versus few kiloparsec). This compactness makes lensed LAEs an ideal probe of dark substructures within the halos of the lensing galaxies, through observable perturbations to the predictions of smooth lensing mass models. We will use the constraints from substructure lensing in this new sample to make the most precise experimental measurement yet of the mass function and overall abundance of sub-halos in galaxy-scale parent halos, which will test a fundamental and robust prediction of the Lambda-CDM model on subgalactic scales. We request zero proprietary period in order to make these important data available immediately to all scientists pursuing lensing measurements of dark-matter substructure.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14190

Proposal Category: GO  
Scientific Category: Resolved Star Formation  
ID: 14190  
Program Title: Trickles of Accretion: Catching a Final Glimpse of Gas in the Disk

Principal Investigator: Nuria Calvet

PI Institution: University of Michigan

The final stages of accretion are complicated to study because very small accretion rates cannot be detected against bright chromospheric emission. Currently, it is not clear what causes accretion to turn off. While the gas has been difficult to observe in the past, new observations of H<sub>2</sub> in far-ultraviolet spectra have proved to be sensitive probes of hot accreting disk gas. We propose to look for gas in a sample of sources which have evidence for remaining dust in the disk, yet lack evidence for accretion in the conventional tracers (e.g. H $\alpha$  and UV excess). We will observe this sample using the Advanced Camera for Surveys/Solar Blind Channel (ACS/SBC) PR130L FUV prism. Similar observations have shown that, while low resolution, the ACS/SBC prism is extremely sensitive to small quantities of gas in circumstellar disks, more sensitive than common accretion diagnostics. We will determine whether or not these sources have any gas remaining in the disk, providing key constraints for disk dissipation theories.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14191

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14191  
Program Title: The Star Formation History and Proper Motion of NGC 6822

Principal Investigator: Andrew Cole

PI Institution: University of Tasmania

Dwarf galaxies are sensitive probes of galaxy formation theory because of both their susceptibility to feedback from star formation and their vulnerability to interactions with neighbors. Theory and observation both suggest that galaxies with stellar masses in the range of 0.1-1 billion solar masses are critical for understanding galaxy assembly and reionization. NGC 6822 is one of only two galaxies in the Local Group in this critical mass range that is outside the virial radius of the Milky Way and M31. We have already measured the star formation history (SFH) of the other galaxy, IC 1613, and discovered it to have a nearly constant star formation rate over a Hubble time. The SFH of NGC 6822, on the other hand, remains unknown for ages greater than  $\sim 3$  Gyr. We propose to obtain the deepest-ever color-magnitude diagrams of two fields in NGC 6822 using ACS/WFC and WFC3/UVIS. In only 7 orbits, we will measure its ancient SFH with resolution of  $\sim 1$  Gyr at the oldest ages, making this an extremely efficient program. The SFH will have accuracy and precision equal to that of IC 1613 ( $\sim 10\%$ , 13 Gyr ago), directly testing the prediction that feedback linked to SFH controls the structural parameters of dwarfs at this mass. It has been suggested that NGC 6822 may have passed within 50 kpc of the Milky Way, altering its structure and gas content. We will target fields in NGC 6822 that have already been observed with ACS/WFC in 2010; measuring the reflex motion of background galaxies over the 6 year baseline we will make the first measurement of its proper motion, constraining its orbit and testing whether NGC 6822 has been influenced by an ancient interaction with the Milky Way.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14192

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14192  
Program Title: Hubble Close-Up of the Disrupting Asteroid P/2012 F5

Principal Investigator: Michal Drahus

PI Institution: Uniwersytet Jagiellonski

To date, four active asteroids have been suspected of rotational disruption. Our data obtained with Keck II in August 2014 show that one of these objects, P/2012 F5, has a very short rotation period of 3.24 hr (shortest known among active asteroids and comets) and recently ejected at least four sizable fragments. Given that the rotation period has not been robustly measured for any other fragmented object in the solar system, P/2012 F5 is a unique laboratory for detailed tests of the rotational breakup scenario. We request 6 orbits of WFC3 imaging in December 2015 to investigate the nature of the fragments and determine the rotation period of the brightest one. This will allow us to quantify, among other things, the mass fraction lost by the nucleus at the disruption, and obtain unquestionable verification of the rotational breakup hypothesis, which makes a testable prediction that the rotation rates of the nucleus and fragments be the same. That knowledge, interesting in and of itself, is also valuable in a broader context, as disrupting asteroids can be an important source of interplanetary dust in the zodiacal cloud and around other stars.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14193

Proposal Category: GO  
Scientific Category: Resolved Star Formation  
ID: 14193  
Program Title: Footprints of the Magnetosphere: the Star- Disk Connection in T Tauri Stars

Principal Investigator: Catherine Espaillet

PI Institution: Boston University

Previous Spitzer infrared observations of disks around young, low-mass pre-main sequence stars have given us an unprecedented look at dust evolution in young objects. Despite this ground-breaking progress in studying the dust in young disks, the relationship between the dust and gas properties in the inner disk remains essentially unknown. Here we propose to quantify the variability of both the dust and gas in the disks surrounding two T Tauri stars to study how or if accretion onto the star is tied to inhomogeneities in the inner disk. To do this, we will use simultaneous HST, Spitzer, and Swift observations to constrain the X-ray, far-ultraviolet, near-ultraviolet, optical, and near-infrared emission of our sample and provide a picture of the interaction between dust and gas in the inner  $\sim 0.5$  AU of the disk down to the stellar surface.



Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14194

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14194  
Program Title: Precision Masses and Distances of Classical Cepheids

Principal Investigator: Nancy Evans

PI Institution: Smithsonian Institution Astrophysical Observatory

An important HST UV legacy is the measurement of the masses of Cepheids. Recently optical interferometry with the Very Large Telescope Interferometer (VLTI) and CHARA has resolved a number of Cepheid binary systems, providing combined spectroscopic and visual orbits. In order to fully exploit this data, we are requesting HST high resolution E140H spectra of 4 Cepheid systems (AX Cir, AW Per, Y Car, and V636 Sco) to measure the orbital velocity amplitude of the hot companion, and thereby determine the mass ratio for the Cepheid-companion system (using the ground-based orbit of the Cepheid). The anticipated velocity accuracy from the STIS spectra will result in masses with uncertainties of 5 to 11%. This will provide a definitive test of evolutionary track physics (specifically main sequence core convective overshoot), and also a comparison of the mass-luminosity relation at two metallicities (the Milky Way and the Large Magellanic cloud).

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14195

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14195  
Program Title: Cloud Evolution on Uranus with K2 and HST

Principal Investigator: John Gizis

PI Institution: University of Delaware

The Kepler K2 mission will monitor Uranus at high photometric precision for three months to determine its interior structure via seismology and to track cloud evolution. This will allow, for the first time, a direct comparison between the disk-integrated weather evolution of a planet and brown dwarfs, and eventually exoplanets. Hubble Space Telescope optical imaging taken during the K2 campaign is needed to anchor our understanding of the atmospheric cloud morphology. We propose observations that will allow us to map the cloud features with HST twice during the K2 campaign.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14196

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14196  
Program Title: The Very Low Mass Object FW Tau b: An Edge-on Brown Dwarf Disk or a Planet Caught in Formation?  
  
Principal Investigator: Gregory Herczeg  
  
PI Institution: Peking University

Planetary mass companions to solar mass stars may form through core accretion, gravitational instabilities in the disk, or protostellar core fragmentation. Recent searches have uncovered about 15 planetary mass companions to young Sun-like stars in orbits of 50-300 AU from the central star. These objects pose significant challenges for formation theories. One particular object, FW Tau b, may be caught in the process of formation. FW Tau b has an apparent brightness and colors consistent with an early L-dwarf, bright emission lines consistent with strong accretion, heavy K-band veiling due to warm dust, and a spatially resolved jet. However, the object mass is not known because the accretion/disk signatures veil the photosphere and have prevented detection of photospheric features and along with a precise measurement of spectral type or temperature. We propose to use STIS G750L to obtain a deep red-optical spectrum of this very faint and enigmatic object to measure its spectral type and thereby infer its mass. If the photosphere is visible, an M-dwarf SpT would mean that the object is a brown dwarf obscured by an edge-on disk. An L-dwarf SpT would indicate a planetary mass object with strong accretion. If entirely veiled, this object would have a remarkably high accretion rate, consistent with it being caught either in its main formation stage or in outburst. A wealth of data, including HST optical photometry, Keck-AO near-IR spectra, and ALMA observations, all suggest that FW Tau b is a very low mass companion at an important stage of evolution. These STIS data are crucial to finally tie these observations together with a SpT and refined mass estimate of this object.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14197

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14197  
Program Title: NGC 6273: Towards Understanding a New Class of Galactic Globular Clusters

Principal Investigator: Christian Johnson

PI Institution: Smithsonian Institution Astrophysical Observatory

Recent work combining HST photometry and ground-based spectroscopy has led to a renaissance in our understanding of Galactic globular clusters. The peculiar large light element abundance variations, discovered nearly 40 years ago by spectroscopy, hid in plain sight what HST finally revealed as a globular cluster's signature of formation: the existence, within a single globular cluster, of multiple populations with unique chemistry that trace out discreet photometric sequences.

HST photometry and ground-based spectroscopy have revealed the existence of a new globular cluster class. These "anomalous" clusters are differentiated from normal globular clusters by exhibiting large ( $>0.1$  dex) intrinsic metallicity dispersions, complex sub-giant branches, and correlated [Fe/H] and s-process abundances. Omega Centauri is the most famous and extreme example of this new class.

Our new high-resolution ground-based spectroscopy demonstrates that NGC 6273, a largely unexplored but massive globular cluster, also exhibits the chemical characteristics of an anomalous cluster. Similar to Omega Cen, NGC 6273 possesses at least 2-3 stellar populations with very different [Fe/H] and s-process abundances; however, further analyses of this cluster are hindered by bulge field star contamination and strong differential reddening. Therefore, we are proposing to combine new WFC3 and archival WFPC2 data to photometrically trace the cluster's populations and isolate cluster members with proper motion cleaning. The HST photometry provides information about population ratios, radial distributions, and formation scenarios that are not possible to obtain by any other means.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14198

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14198  
Program Title: Establishing the nature of the far-UV emission from the double pulsar.

Principal Investigator: Oleg Kargaltsev

PI Institution: George Washington University

The unique double neutron star (NS) binary J0737-3039 contains two pulsars, the recycled millisecond pulsar A and the ordinary old pulsar B. Pulsar A is expected to dominate the optical to X-ray spectrum. X-ray observations, mainly sensitive to a hot (polar cap) emission component, do not constrain the whole NS surface temperature. In our previous HST observation we detected the far-UV (FUV) emission but only in one broad filter. However, from a single flux measurement one cannot infer the physical nature and origin of emission (thermal from the NS surface or nonthermal from the pulsar magnetosphere). The FUV emission is too faint to detect it with another filter, but deep optical observation will allow us to discriminate between the two possibilities. If thermal nature of the FUV emission is confirmed, it would establish the remarkably high NS surface temperature requiring revision of existing NS cooling models.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14199

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14199  
Program Title: Refsdal Redux: Precise Measurements of the Reappearance of the First Supernova with Multiple Resolved Images  
Principal Investigator: Patrick Kelly  
PI Institution: University of California - Berkeley

In 1964, Refsdal first considered the possibility that a powerful gravitational lens could create multiple images of a well-aligned background supernova (SN) explosion. For such a system, the time delays between the SN images depend on both the matter distribution in the lens, and the cosmic expansion rate. In HST exposures of the MACSJ1149 cluster taken in November 2014, we discovered the first multiply imaged SN, which we have named 'Refsdal.' Four images of the SN create an Einstein Cross around an early-type cluster member. SN Refsdal is expected to reappear during Cycle 23 in a different image of the host galaxy (offset by 8'') created by the cluster's potential. Our HST imaging and spectroscopy now show that SN Refsdal is a peculiar Type IIP SN similar to 1987A at redshift  $z=1.5$ .

We propose a WFC3 imaging program to detect the reappearance (10 orbits) and a follow-up ToO program to construct near-IR light curves in two bands (up to 28 orbits). Comparing the new light curve to the current four images, we will measure precise relative magnifications and time delays. This will make SN Refsdal into a powerful probe of the cluster mass distribution and lay a foundation for the future use of SN time delays for constraints on cosmological parameters. Comparison among the five light curves will also allow us to measure microlensing fluctuations, which can constrain the elliptical lens' and intracluster stellar populations. Finally, this Cycle 23 imaging will provide late-time light curves for the four highly magnified images ( $\sim 15-20x$ ) in the Einstein Cross. These will enable an improved comparison to the low-redshift 87A-like population and an estimate of the  $56Ni$  mass.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14200

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14200  
Program Title: Revealing the host galaxy of a strong Milky Way-type 2175 Angstrom absorber at  $z = 2.12$   
Principal Investigator: Jingzhe Ma  
PI Institution: University of Florida

We propose WFC3/IR G141 grism and F140W direct imaging observations (3 orbits) of a strong Milky Way-type 2175 Angstrom absorbing galaxy at  $z = 2.12$  in the quasar spectrum towards QSO J1211+0833 from the Sloan Digital Sky Survey (SDSS). We conducted follow up observations with the Echelle Spectrograph and Imager (ESI) onboard the Keck-II telescope and the Ultraviolet and Visual Echelle Spectrograph (UVES) on the VLT. Given the simultaneous presence of C I, CO, and the 2175 Angstrom bump, combined with the high metallicity, high dust depletion level and overall low ionization state of the gas, J1211+0833 supports the scenario that the presence of the bump requires an evolved stellar population. We speculate that the host of the J1211+0833 2175 Angstrom bump is likely to be an evolved and chemically-enriched disk galaxy. The proposed observations will enable us to, for the first time, study the properties (morphology, impact parameter, star formation rate, stellar mass) of the host galaxy of a 2175 Angstrom absorber beyond the local Universe, which our existing observational data cannot provide. This population may be used as unique tracers of chemical enrichment and star-forming galaxies at high-redshift.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14201

Proposal Category: GO  
Scientific Category: Unresolved Star Formation  
ID: 14201  
Program Title: Lyman alpha escape in Green Pea galaxies (give peas a chance)

Principal Investigator: Sangeeta Malhotra

PI Institution: Arizona State University

What makes a star-forming galaxy a Lyman-alpha (LyA) emitter? The answer to this question is essential to understand a large fraction of high-redshift galaxies and reionization. This answer is best found for low-z galaxies, where there is abundant multiwavelength data but UV spectroscopy of LyA line is needed with HST.

Green Pea galaxies are the best low-redshift analogs of high redshift LyA galaxies, because they

- (1) have high specific star-formation rates,
- (2) have metallicities that are unusually low for their stellar masses, and
- (3) are spatially compact.
- (4) Archival COS spectra show LyA emission from all observed Green Peas; and high EW LyA from 7 out of 9 GPs.

We propose to systematically study the dependence of LyA escape fraction on (A) metallicity (B) dust column (C) porosity of neutral gas and (D) outflow velocities to determine the dominant factor(s) in making LyA escape possible. The nine GPs available in the archives are the ones with lowest metallicities and dust extinctions. We propose COS spectroscopy for 20 Green Peas to span the full range of their metallicities, dust columns, and H-alpha equivalent widths.

With COS spectra we will measure Ly $\alpha$  flux and compare it to H-alpha to determine Ly $\alpha$  escape fraction. We will compare velocity profiles of LyA and H-alpha to determine the outflow velocities, and constrain absorbing columns of neutral gas. By measuring optical depth in SII and CII we will estimate the covering fraction of neutral gas. NUV images

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14202

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14202  
Program Title: The Unprecedented Supernova Metamorphosis of SN 2014C

Principal Investigator: Dan Milisavljevic

PI Institution: Smithsonian Institution Astrophysical Observatory

Recent observations of major eruptions precluding supernova explosions within one year of core collapse have challenged long held notions of stellar evolution. These events are not easily explained by our current understanding of the physical mechanisms that drive mass loss in evolved massive stars, and the disconnect between theory and observation presents a real problem for many fields of research that depend on the predictions of stellar evolution models. Our group has been leading an extensive X-ray-through-radio monitoring campaign of a unique supernova metamorphosis -- SN 2014C -- that extends the poorly understood timescale between intensified mass loss and core collapse. A crucial component of our multi-wavelength investigation is UV spectroscopy and high-resolution UV/optical imaging, which only HST can deliver. The combined data set will enable a global understanding of the SN explosion and its delayed interaction with surrounding circumstellar material, as well as a detailed examination of the mass loss and evolutionary transitions a massive star may undergo in its final stages approaching core collapse.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14203

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14203  
Program Title: Confirmation of the First Ultracompact Black Hole X-ray Binary

Principal Investigator: James Miller-Jones

PI Institution: Curtin University

We have recently detected strong, steady radio emission from the well-known X-ray source X9 in the globular cluster 47 Tuc. The level of radio emission rules out the previous interpretation of the source as a cataclysmic variable, and instead suggests that it hosts a quiescently accreting stellar-mass black hole. An existing far-UV spectrum shows a strong C IV 1550 emission line, but no sign of He II 1640 emission. Narrow-band HST photometry exhibits no H $\alpha$  excess (down to an equivalent width limit of  $>\sim -10\text{\AA}$ ) and Chandra X-ray observations show an unusual feature that is likely attributable to O VIII emission. All of this evidence, as well as the unusually high X-ray luminosity of the system, points to X9 being an ultracompact binary in which a stellar-mass black hole accretes material from a white dwarf -- which if confirmed would be the first such system ever discovered. Here, we request HST observations to obtain a broad-band optical spectrum of X9 to confirm or reject the ultracompact nature of the system. The resulting data will also be used to evaluate the optimal strategy for determining the system parameters, in particular the orbital period.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14204

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14204  
Program Title: Multiple stellar populations in two young Large Magellanic Cloud clusters: NGC1755 and NGC1866  
Principal Investigator: Antonino Milone  
PI Institution: Australian National University

Multiple sequences are present in the CMD of nearly all the old Galactic globular clusters (GCs) and correspond to multiple populations with different helium and light-elements abundance. Multiple populations are not a peculiarity of old GCs, indeed extended main-sequence turn off (eMSTO) have been detected in most of the intermediate-age clusters in the Magellanic Clouds.

The conditions under which GCs experience the formation of multiple populations remain controversial. An unique angle on this problem can be provided by the young star clusters but the many investigations reported no evidence for multiple populations in clusters younger than 1Gyr to date. Surprisingly, we have recently discovered the first case of a ~300-Myr-old cluster with split main sequence and eMSTO. This finding has been possible thanks to the use of UVIS photometry in the appropriate F336W and F814W filters.

To properly constraint the multi-population phenomenon in young clusters, we propose deep UVIS imaging of the ~150 Myr-old LMC clusters NGC1866 and NGC1755 which, according to the analysis of archive HST data are excellent candidates to host multiple populations.

The proposed observations will allow us to understand if multiple populations are present in very-young clusters. We will be able to measure the age difference between the populations with errors of less than 20 Myr and detect very small He and CNO differences.

NGC1755 and NGC1866 have different masses, therefore the presence or the absence of multiple sequences in their

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14205

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14205  
Program Title: Early Quiescent Galaxies Under the Magnifying Glass

Principal Investigator: Andrew Newman

PI Institution: Carnegie Institution for Science

By a redshift of  $z \sim 2$ , half of the massive galaxy ( $>10^{11} M_{\odot}$ ) population consists of systems with little or no star formation and physical sizes that are remarkably small ( $\sim 1$  kpc) for their mass. Much effort has been devoted to understanding the star-forming progenitors of these "red nuggets" and their substantial growth in size over the last 11 Gyr. However, major questions remain. A key barrier is our inability to resolve the structure and dynamics of these compact galaxies, which are only marginally resolved even with HST. This proposal addresses this limitation by harnessing gravitational lensing. We propose observations of two spectroscopically confirmed quiescent galaxies at  $z=2-3$  that are magnified by foreground clusters. By coupling this magnification with HST resolution, our proposed observations will allow us to: (1) Resolve the central stellar densities of these galaxies within half of the effective radius, thereby stringently testing the hypothesized "inside out" growth paradigm and constraining the physical mechanisms driving size growth; (2) Probe the homogeneity of the stellar populations of these compact galaxies by measuring color gradients within  $\sim 1$  kpc; (3) Construct lens models to interpret existing spatially-resolved NIR spectroscopy and measure resolved stellar kinematics for the first time in these systems. Our proposed targets are rare and valuable resources that provide the only route toward better resolving the internal structure of  $z > 2$  quiescent galaxies in advance of JWST.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14206

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14206  
Program Title: A New Threshold of Precision, 30 micro-arcsecond Parallaxes and Beyond

Principal Investigator: Adam Riess

PI Institution: The Johns Hopkins University

The ESA Gaia mission is poised to dramatically tighten the distance scale for all stellar types, with a billion Milky Way parallaxes reaching 10 microarcseconds for  $V < 12$  mag, 20 microarcseconds at  $V = 15$ , and 200 microarcseconds at  $V = 20$ . These data will have enormous impact on nearly any investigation that makes use of stellar astrophysics, including stellar evolution, galactic archeology, exoplanet characterization, and physical cosmology. Measurements this revolutionary demand a number of independent tests for the presence of systematic errors. We have developed a method that can measure parallaxes of the best-observed stars to 30 microarcseconds with WFC3 using spatial scanning (Riess et al. 2014). We propose to obtain 4 new epochs of spatial-scanning measurements for 9 previously observed fields in order to collect 150 stellar parallaxes and improve the sample mean precision to 30 microarcseconds, sufficient for a meaningful test of Gaia. The proposed doubling of the temporal coverage for these fields will deliver (1) a 40% improvement in the precision of the HST parallaxes which otherwise limit the precision of the comparison, (2) the ability to weed out relevant astrometric binaries which could otherwise pollute a number of parallax

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14207

Proposal Category: GO  
Scientific Category: Debris Disks  
ID: 14207  
Program Title: Inventoring Gas in Debris Disks: UV Spectroscopy of Eta Tel

Principal Investigator: Aki Roberge

PI Institution: NASA Goddard Space Flight Center

Debris disks stand between gas-rich protoplanetary disks and mature planetary systems, shedding light on the late stages of planet formation. Their dust component has been extensively studied, yet has provided little information about disk chemical composition. More information can be provided by their gas content, but astonishingly little is known about it. Only two debris disks have measurements of their gas composition, which is shockingly carbon-rich (Beta Pictoris and 49 Ceti). Basic questions remain unanswered. What are the typical gas-to-dust ratios in debris disks? What is the chemical composition of debris gas and its parent material? The answers to these questions have profound implications for terrestrial planet assembly and the origins of planetary atmospheres.

Most detections of debris gas to date were achieved with line of sight UV/optical absorption spectroscopy of edge-on disks, using the central star as the background source. This technique is far more sensitive to small amounts of gas than emission line studies. The UV bandpass is particularly important, since strong transitions of numerous atomic and molecular species lie there. We propose extending our intriguing studies of debris gas with STIS UV spectroscopy of a highly promising debris disk system, Eta Tel. This disk is edge-on and contains circumstellar atomic gas (CII). We will measure column densities of the most important gas species, find the relative elemental gas abundances, and determine the gas mass using a powerful gas disk modeling code. We will also divide our observations into two visits, to search for signs of star-grazing exocomets, which are seen in both Beta Pic and 49 Cet.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14208

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14208  
Program Title: Frontier Fields Supernova Search

Principal Investigator: Steven Rodney

PI Institution: The Johns Hopkins University

The HST Frontier Fields (HFF) program presents an extraordinary opportunity for the detection of lensed, high-redshift transients (primarily supernovae, SNe) out to  $z \sim 3$ . Over the last 2 years we have been searching the HFF data and following up lensed transients and their host galaxies with HST imaging and ground-based spectroscopy. We have discovered  $\sim 40$  SNe, which will contribute to tests of Type Ia SN progenitor models by improving rate measurements reaching to  $z \sim 2.5$ . Our sample also includes a subset of highly magnified objects like the multiply imaged SN Refsdal. Positions and time delays of such multiply imaged transients provide powerful constraints for the dark matter distribution in galaxy clusters. In addition, our collection of lensed Type Ia SNe are providing a rigorous test of cluster mass models by directly measuring the lensing magnification. Finally, the rapid and deep imaging of the HFF program has surprisingly opened up a new discovery space, revealing at least one peculiarly fast and faint astrophysical transient. We propose to extend this program into the third and final year of the Frontier Fields survey, finishing the collection of this unique and diverse sample of distant transients.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14209

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14209  
Program Title: The Final UV Frontier: Legacy Near-UV Imaging of the Frontier Fields

Principal Investigator: Brian Siana

PI Institution: University of California - Riverside

The Hubble Frontier Fields (HFFs) are proving to be as scientifically interesting at  $z < 3.5$ , as at  $z > 7$ , the epoch for which it was designed. In Cycle 21, we observed three HFFs with WFC3/UVIS near-UV (NUV) imaging (8 orbits each of F275W, F336W). Here we propose to image the remaining three fields (which offer higher magnification at  $z < 1.5$ ) to enable the following:

The high magnification provided by gravitational lensing enables study of star formation (SF) in dwarf galaxies at  $0.75 < z < 1.5$ . With typical sensitivities of  $> 0.03 M_{\text{sun}}/\text{yr}$ , we can study the burstiness of SF (by comparing to grism Halpha), the UV spectral slopes and extinction curves, and the sizes and luminosities of SF clumps on scales  $< 100$  pc.

The NUV identifies the Lyman break of dwarf galaxies at  $1.5 < z < 3.5$  that often have featureless continua, enabling measure of the global SF rate density at its peak epoch. This is the redshift range of 80% of multiply-imaged systems, the primary constraints on the cluster mass models. The NUV will help identify multiply-imaged systems, ensuring that the HFF program attains its stated goals.

At  $z \sim 2.4$ , F275W can detect escaping Lyman continuum behind clusters much more efficiently than in the field. Within cluster galaxies, the NUV provides a high-resolution probe of SF ( $> 0.02 M_{\text{sun}}/\text{yr}$ ) not available with existing data sets. We will characterize galaxies transitioning between the blue cloud and red sequence, including "jellyfish" galaxies with SF tails of stripped gas, and ellipticals and SOs with residual SF only apparent in the UV. Completing the sample will provide insight into how cluster mass and dynamical state affect quenching of cluster galaxies.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14210

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14210  
Program Title: Improved masses for two new low-redshift strong lens galaxies: Do giant ellipticals really have a heavy IMF?  
Principal Investigator: Russell Smith  
PI Institution: University of Durham

We propose WFC3/UVIS imaging of newly-identified strong gravitational lenses from SNELLS, the "SINFONI Nearby Elliptical Lens Locator Survey", at the ESO VLT. Our novel approach uses IFU observations to search for lensed background line emitters behind very low redshift ( $z < 0.06$ ) massive ellipticals. The key characteristic of such nearby lenses is that the gravitational deflections are dominated by stellar mass, with only very small contributions from dark matter. As such, they provide uniquely robust constraints on the stellar mass-to-light ratio (M/L), and hence the initial mass function (IMF).

To date, SNELLS has discovered two new lenses, SNL-1 at  $z=0.031$  and SNL-2 at  $z=0.052$ . Analysing these systems, as well as the previously-known low- $z$  lens ESO325-G004, we found that all three have M/L consistent with a standard MW-like IMF. This result is very surprising in the context of recent works which favour Salpeter or bottom-heavy IMFs in massive ellipticals.

A major limitation of our present analysis is that SNL-1 and SNL-2 are two-image systems, and the arcs are unresolved in our ground-based observations. As a result, the lensing mass is degenerate with the component of external shear along the image separation axis. This degeneracy can be broken by measuring the tangential extent of the arcs (or more generally, the detailed structure of the lensed images).

In this application, we propose HST observations which will spatially resolve the arcs, and greatly improve the robustness of our lensing mass estimates. The data will reduce the error on M/L by a factor  $\sim 5$  and, combined with

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14211

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14211  
Program Title: Diagnosing the super-Eddington accretion/outflow regime using the microquasar MQ1 in M83  
  
Principal Investigator: Roberto Soria  
  
PI Institution: Curtin University

We are addressing an important, unsolved astrophysical problem: determining the radiative and mechanical power of black holes at extreme rates of mass accretion, at or above their Eddington limit. In our recent multiband imaging study of the spiral galaxy M83 with HST/WFC3, Chandra and ATCA, we discovered a stellar-mass black hole with strong radio, X-ray and optical line emission. WFC3 optical imaging resolves the source into a core and two lobes or hot spots (separated by 0".6), the result of powerful jets interacting with the surrounding interstellar medium.

We now propose to use STIS to do spatially-resolved spectroscopy of this microquasar, with the following objectives:

- a) determine whether the optical line emission of the core is mostly from photo-ionized gas and the lobe emission from shock-ionized gas;
  - b) use the optical line luminosities as proxies for the integrated radiative and mechanical power of the black hole;
  - c) measure or constrain the expansion velocity of the gas in the core and in the lobes, which will help us determine the duration and integrated energy of this powerful accretion/ejection phase.
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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14212

Proposal Category: SNAP  
Scientific Category: ISM and Circumstellar Matter  
ID: 14212  
Program Title: A Snapshot Imaging Survey of Spitzer-selected Young Stellar Objects in Nearby Star Formation Regions

Principal Investigator: Karl Stapelfeldt

PI Institution: NASA Goddard Space Flight Center

Young circumstellar disks are the dusty reservoirs in which planetary systems may eventually form. Previous HST imaging surveys have spatially resolved about twenty circumstellar disks around young stars in nearby molecular clouds. Providing key measurements of disk inclinations, outer radii, asymmetries, vertical thicknesses, and dust properties, these observations have supplied valuable constraints on theories of star and planet formation. Most of this prior work was based on source identifications made 30 years ago by the IRAS survey. With its improved sensitivity and spatial resolution, the Spitzer Space Telescope identified numerous new members of nearby star-forming regions that are optically visible, not yet observed with HST, and which possess infrared excess  $> 40$  mJy at 24 microns (5 times fainter than the IRAS survey 25 micron sensitivity). This group of objects consists of low mass stars, young brown dwarfs, transition disks, and edge-on disks that obscure their central sources. We propose a high dynamic range ACS snapshot survey of this lower-luminosity young star population. Our goals are (1) to determine the frequency of disk detections in scattered light; (2) to measure disk sizes, internal structures, and constituent dust properties in order to test theories of protoplanetary disk evolution; (3) to identify the nearly edge-on systems which are particularly favorable for studies of disk geometry; and (4) to discover faint substellar companion objects. This survey will extend previous HST young star imaging of protoplanetary environments from a solar mass down to the substellar limit, revealing their nature and frequency in the galaxy.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14213

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14213  
Program Title: Defining New IR-Bright Flux Standards for Cosmology Applications

Principal Investigator: Pier-Emmanuel Tremblay

PI Institution: Space Telescope Science Institute

The uncertainties on the determination of the nature of the dark energy, that is driving the observed accelerating cosmic expansion, depend critically on the stellar flux standards that are used to calibrate the relative flux of redshifted type Ia supernovae. Currently, the most precise and internally consistent set of fluxes are HST spectrophotometry which are based on computed models atmospheres for three hot pure-hydrogen white dwarfs. Our proposal will directly address the accuracy of this calibration, one of the current current barriers to understand the nature of dark energy.

We request 4 orbits to observe two nearby pure-hydrogen atmosphere white dwarfs with significantly cooler temperatures than the current hot white dwarf HST standards. These cooler objects are now accurately modeled by our state-of-the-art 3D model atmospheres and do not suffer from the known shortcomings in models of hot white dwarfs and main-sequence stars. In addition to providing the first robust external confirmation of the HST flux scale in the optical, these new flux standards will be especially useful in the JWST era as standards for the near-IR and IR regions, and their colors will be more similar to those of high-redshift supernovae and galaxies. Furthermore, the parallax of such close stars can be measured with higher precision, so that the absolute flux level can be established as well as the relative flux vs. wavelength.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14214

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14214  
Program Title: The Suppression of Convection in Magnetic White Dwarfs

Principal Investigator: Pier-Emmanuel Tremblay

PI Institution: Space Telescope Science Institute

Magnetic white dwarfs account for ~10% of the overall remnant population, and contribute an even more significant fraction in the high-mass regime. An understanding of magnetic remnants is critical to derive a precise star formation history and initial mass function in the Galactic disk from the the local volume-complete sample of white dwarfs. The origin of magnetic white dwarfs remains elusive, and they could be remnants of magnetic main-sequence stars or the product of white dwarf mergers, the latter scenario providing constraints on the nature of type Ia supernovae. In the next decade, Gaia will provide precise distances, masses, and luminosities for all magnetic white dwarfs, allowing to trace their evolution path.

We request to test the prediction of our new 3D radiation magnetohydrodynamics simulations of magnetic white dwarf atmospheres that convective energy transfer is suppressed in the line forming regions for  $B > 5$  kG. This result implies a major change in the manner magnetic white dwarfs should be modeled, from the predicted colors to the cooling rates. We propose to observe a cool magnetic white dwarf with  $B = 10$  kG where we predict that convection is suppressed at the surface, as well as two standard convective remnants with similar parameters. The radiative and convective solutions are very similar in the optical, but the UV slope will confirm whether convective energy transfer is suppressed. As a consequence, we request 3 HST orbits with COS/FUV to confirm the 3D predictions and set the theoretical framework for the 10,000 magnetic white dwarfs that Gaia will observe.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14215

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14215  
Program Title: The pristine globular cluster population of the primordial relic galaxy NGC1277

Principal Investigator: Ignacio Trujillo

PI Institution: Instituto de Astrofísica de Canarias

Galaxy mass assembly is driven dually by in-situ star formation and mergers, though which modes dominate in galaxies of different mass and at different epochs is poorly understood. These bimodal processes are thought to be mirrored in the formation mechanisms for ancient red and blue globular clusters (GC) present in massive galaxies. Whereas the red GCs are theorized to form in situ together with the core of the massive galaxy, the blue subpopulation is expected to have an external accreted origin. This scenario, however, continues presently untested. The proposed observations (2 orbits in the g and z filters using the ACS camera) will provide a direct test of this accretion hypothesis by characterizing the GC population of a massive galaxy that has survived untouched since its early assembly at  $z > 2$ : NGC1277. If the accretion scenario is correct, the GC color distribution of NGC1277 will be unimodal (having only red GCs). This result would provide direct constraints on the early accretion and assembly of massive galaxies in the early universe.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14216

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14216  
Program Title: RAISIN2: Tracers of cosmic expansion with SN Ia in the IR

Principal Investigator: Robert Kirshner

PI Institution: Harvard University

Observations of SN Ia in the IR offer the most promising way to construct an accurate cosmic expansion history to constrain the properties of dark energy. Systematic errors introduced by photometry, light curve fitters, and by dust extinction pose the limit of precision for today's large optical samples. Theory predicts and empirical evidence demonstrates that SN Ia are more nearly standard candles in infrared bands than in optical bands. Dust absorption is 3 times smaller in the near IR. As a result, an sample with observations in the rest frame IR is a powerful way to verify the world's work on dark energy with stringent and illuminating cross-checks. In Cycle 20, we followed up the flood of SN Ia discovered by PanSTARRS with HST. Now we propose another sample of 25 SN Ia discovered with Dark Energy Survey. DES can find SN Ia, we can confirm the type and redshift with spectra, and then make effective HST observations in the restframe IR observations using WFC3/IR to derive precise (and accurate!) cosmic distances to improve knowledge of the dark energy equation of state,  $w$ . For Cycle 23, we propose to shift the redshift range to  $z = 0.5$ , the era when acceleration began. There, the restframe Y band fits neatly into

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14217

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14217  
Program Title: Neptune's Evolving Inner Moons and Ring-Arcs

Principal Investigator: Mark Showalter

PI Institution: SETI Institute

This program will address three key science goals related to the rings and inner moons of Neptune. (1) We will recover S/2004 N 1, Neptune's 14th moon, whose discovery was announced by STScI in 2013. This 8-10 km moon orbits between the much larger moons Larissa and Proteus, raising questions about its origin and orbital stability. Measurements from Cycle 23 will supplement the only existing measurements from 2004-2005 and 2009, giving us necessary confirmation of the discovery and providing much stricter constraints on the moon's orbital elements. (2) We will locate Naiad, the innermost known moon, whose orbital position appears to have jumped by 81 degrees in orbital longitude between 2002 and 2004. New measurements will determine whether (a) the 2002 measurements were erroneous, or (b) the moon follows a highly perturbed orbit. If the latter, our measurements will place strong constraints on the nature of these unknown perturbations. (3) We will revisit the arc system embedded in the Adams ring of Neptune. The leading arcs have disappeared since the 1989 Voyager flyby; the trailing arcs have been more stable, although they appear to be fading slowly. We will investigate this unexplained trend, and also seek out evidence for other subtle changes in the rings, by obtaining the first rotationally complete, visual-band profile of the ring-arcs since 1989.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14218

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14218  
Program Title: The Atmospheres of Two Low-Mass, Low-Density Exoplanets Transiting a Young Star

Principal Investigator: Zachory Berta-Thompson

PI Institution: Massachusetts Institute of Technology

Our Solar System hosts no planets with masses between Earth and Uranus, yet such planets abound throughout the Galaxy. Many of these low-mass exoplanets are also low-density, requiring gas-rich envelopes to explain their large sizes. We propose to use WFC3/IR to observe transmission spectra for two planets at the extreme low-density limit of this population: Kepler-51b and Kepler-51d. Despite being less massive than 10 Earth masses, the Kepler-51 planets are almost as big as gas giants. They are 500 Myr old and probably still thermally contracting. Kepler-51 offers the opportunity to observe an early snapshot in the evolutionary histories of two low-mass planets formed from the same protoplanetary disk. These planets have low surface gravities and large atmospheric scale heights, and their atmospheres are easier to observe than any other multiple transiting planet system. Transmission spectra of the Kepler-51 planets will probe chemistry and cloud formation in warm H/He atmospheres, through comparisons both between the two coeval planets and against other exoplanets observed with WFC3. If Kepler-51b and Kepler-51d are not too cloudy, these observations could provide the first detections of molecules (including water, methane, and ammonia) in the atmospheres of exoplanets less massive than Uranus. If we find clouds on neither, either, or both planets, we will push our understanding of cloud processes into unexplored temperature and circulation regimes. Our proposed observations of these two young planets will shed new empirical light on the origins, properties, and evolution of low-mass, low-density exoplanets.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14219

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14219  
Program Title: Homogeneous Distances and Central Profiles for MASSIVE Survey Galaxies with Supermassive Black Holes  
  
Principal Investigator: John Blakeslee  
  
PI Institution: Dominion Astrophysical Observatory

Massive early-type galaxies are the subject of intense interest: they exhibit the most massive black holes (BHs), most extreme stellar IMFs, and most dramatic size evolution over cosmic time. Yet, their complex formation histories remain obscure. Enter MASSIVE: a volume-limited survey of the structure and dynamics of the 100 most massive early-type galaxies within ~100 Mpc. We use integral-field spectroscopy (IFS) on sub-arcsecond (with AO) and large scales for simultaneous dynamical modeling of the supermassive BH, stars, and dark matter. The goals of MASSIVE include precise constraints on BH-galaxy scaling relations, the stellar IMF, and late-time assembly of ellipticals. We have already obtained much of the needed IFS and wide-field imaging for this project; here, we propose to add the one missing ingredient: high-resolution imaging with HST. This will nail down the central profiles, greatly reducing the degeneracy between M/L and BH masses in our dynamical orbit modeling. Further, we will measure efficient, high-quality WFC3/IR SBF distances for all targets, thereby removing potentially large errors from peculiar velocities (especially in the high-density regions occupied by massive early-types) or heterogeneous distance methods. Distance errors are insidious: they affect BH masses and galaxy properties in dissimilar ways, and thus can bias both the scatter and slopes of the scaling relations. The measured distances and central profiles will constrain the stellar, dark matter, and BH masses to high precision, ensuring the success of our ambitious MASSIVE survey.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14220

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14220  
Program Title: Mapping the Substellar Mass-Luminosity Relation Down to the L/T Transition

Principal Investigator: Trent Dupuy

PI Institution: University of Texas at Austin

Substellar models underpin our theoretical understanding of brown dwarfs and gas-giant exoplanets, so assessing their accuracy is paramount. The past several years have seen progress in testing models thanks to a growing number of dynamical (total) masses for brown dwarf binaries determined via (relative) orbit monitoring from ground-based AO. However, the strongest tests of models require individual masses, particularly for calibrating the mass-luminosity relation. This is poorly constrained over the range of spectral types most influenced by clouds (mid-L to early-T). Given the observed prevalence of clouds in the atmospheres of directly imaged planets, testing models at such temperatures is crucial.

We propose a 3-year program to obtain individual masses for a sample of 11 substellar binaries. Our proposal builds on nearly a decade of orbital monitoring from the ground to measure dynamical total masses. Our goal is thus to measure precise mass ratios, utilizing HST's unique wide-field, high-angular resolution astrometric capabilities. We will obtain WFC3-UVIS images capturing our targets and numerous reference stars so that we can measure the relative amount of orbital motion in each component to determine mass ratios. Three of our targets have I-band photocenter orbits measured at USNO and VLT and thus only require one epoch of resolved I-band imaging to unlock individual masses. We will use this first large sample of substellar individual masses to map out the mass-luminosity relation over a wide range of temperatures (1000-2000 K) including the L/T transition. This will become a touchstone sample for tests of ultracool atmospheric models in the era of JWST.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14221

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14221  
Program Title: HST Confirmation and Characterization of a Potentially Habitable World

Principal Investigator: David Ehrenreich

PI Institution: Observatoire de Geneve

Atmospheric characterization of exoplanets in habitable zones is one of the greatest challenge of astrophysics. In fact, all known potential targets either do not transit, or they transit stars too faint or distant, making them impossible to probe with transit spectroscopy. A recently announced K2 planet candidate found in the habitable zone of a nearby M dwarf, could be a game changer as the first habitable-zone super-Earth (2.2  $R_{\text{Earth}}$ ) amenable to characterization. We propose to use HST to (1) validate the planet candidate by observing a high-precision near-infrared transit with WFC3 and (2) characterize its atmosphere by detecting an extended hydrogen exosphere in the far ultraviolet with STIS. Hydrogen escape is indeed a telltale sign of terrestrial planets enduring a runaway greenhouse effect. Further considerations on the habitable potential of the planet thus need to be vet against a detection of hydrogen escape. Our recent STIS Lyman-alpha observations of a moderately irradiated neptune show that extended upper atmospheres can reach much larger sizes around such planets than around very hot exoplanets. We could thus obtain a significant detection with a modest amount of HST orbits. In parallel, we started a ground-based campaign to constrain the yet unknown mass of this planet with Doppler measurements. Combining the Lyman-alpha transit depth with the measurement of the planet bulk density (from the accurate near-infrared transit and the Doppler mass), will reveal for the first time whether an exoplanet can be telluric and actually habitable, or if it is losing its water because of a runaway greenhouse effect.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14222

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14222  
Program Title: Full HST coverage of a comet-like exoplanet in transit

Principal Investigator: David Ehrenreich

PI Institution: Observatoire de Geneve

Exoplanets orbiting at close distances from their stars could lose some fraction of their atmospheres because of the extreme stellar irradiation. Hot rocky planets might have lost all of their atmospheres through this process, having evolved from larger progenitors with gas envelopes, possibly Neptune-mass exoplanets. The signature of this mass loss could be observed with HST/STIS at Lyman-alpha; however, there were no convincing detections of this effect for planets less massive than gas giants. New HST observations of the Neptune-mass exoplanet GJ 436b reveal a spectacular atmospheric escape. Although not strong enough to deplete the atmosphere of the planet in the lifetime of the parent star, it creates a huge exospheric cloud of atomic hydrogen eclipsing over half the stellar disk at Lyman-alpha. The exospheric cloud transit has an early ingress and numerical simulations predict it could last for almost half the 2.6-day revolution period of the planet, because of an extended comet-like tail. However, the current data do not stretch over this duration, and we propose here to use HST/STIS to cover the full transit. This will reveal the exact shape of GJ 436b exospheric cloud and allow us to discriminate between the two possible mechanisms sculpting the cloud. The results could be applied to all moderately-irradiated exoplanets, in particular the planets around M dwarfs that will be detected by the TESS mission.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14223

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14223  
Program Title: The Planck Dusty Gravitationally Enhanced subMillimeter Sources (GEMS)

Principal Investigator: Brenda Frye

PI Institution: University of Arizona

The brightest, strongly lensed high-redshift galaxies are veritable gems to study intense star formation in the early Universe. How do the high and irregular "clumpy" stellar and gas mass surface densities, strong radiation fields, and high turbulence regulate the rapid growth of these galaxies? We will use HST/WFC3 to investigate the stellar component of 6 of the brightest high-redshift sub-millimeter galaxies on the sky, which were recently discovered with the Planck all-sky survey. All are giant arcs or partial Einstein rings with angular sizes up to 17" in shallow CFHT K-band or Spitzer/IRAC imaging. FIR luminosities are  $10^{13-14} L_{\text{sun}}$ , with dust SEDs strongly dominated by intense star formation near the maximum possible rates ("maximal starbursts"). All have spectroscopic redshifts  $z=2.2-3.6$  and magnification factors  $\geq 20$ . We already have multiwavelength data sets to characterize their gas and dust column densities and kinematics, and propose here to acquire deep, high-resolution rest-frame optical imaging to study the stellar populations and morphologies. With WFC3 imaging in F110W & F160W we will:

- (1) constrain the stellar morphologies, ages, and mass-to-light ratios
- (2) Identify clumps and measure their properties to test several clump formation scenarios
- (3) Enhance our on-going lens modeling through the most accurate positions, morphologies and colors

Only the brightest of the arc clumps are visible from the ground in the NIR. To register the flux along the full extent of the arcs, and importantly to probe individual star forming regions of the size of 30 Dor at  $z \sim 2-3$  in the brightest high- $z$

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14224

Proposal Category: GO  
Scientific Category: Resolved Star Formation  
ID: 14224  
Program Title: The lowest mass galaxies with extended star formation history: a new cosmological challenge  
  
Principal Investigator: Carme Gallart  
  
PI Institution: Instituto de Astrofísica de Canarias

Dwarf galaxies are the most numerous type of galaxies in the present-day Universe. They are thought to be the first galaxies to form and the basic building-blocks of larger galaxies. They are thus, key astrophysical objects for understanding the most common mode of galaxy formation and how they relate to the build-up of larger structures in the Universe.

The faintest dwarf galaxies that have been discovered in the Local Group (the so-called ultra-faint dwarfs, UFD) have been shown to contain similar ancient populations, which could indicate that star formation in the smallest sub-halos was suppressed by a global outside influence such as cosmic reionization. This conclusion, however, is severely challenged by the recently discovered Hydra II and Eridanus II UFD, which ground-based color-magnitude diagrams show clear indications of the presence of an intermediate-age, or even, young population, like in a third UFD, Leo T. The goal of this proposal is to determine the complete star formation history of the only three (known so far) UFD galaxies that present an extended period of star formation. We will determine whether they began forming stars before or after the reionization. For that we will obtain deep color-magnitude diagrams and derive star formation histories with an exquisite age resolution ( $< 1$  Gyr at old ages).

The proposed observations will place strong constraints on the formation mechanisms of the faintest galaxies in the Universe, on their subsequent evolution, and on the conditions of the early Universe. This will have important implications for our understanding of galaxy formation and evolution in general.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14225

Proposal Category: GO  
Scientific Category: ISM and Circumstellar Matter  
ID: 14225  
Program Title: Small Magellanic Cloud Ultraviolet Dust Extinction: A Focused Study of Four Sightlines Near a Molecular Cloud with Variable 2175 Å bumps  
Principal Investigator: Karl Gordon  
PI Institution: Space Telescope Science Institute

We propose to obtain low-resolution STIS spectra covering the entire ultraviolet for four stars in the SMC to measure their UV extinction curves and HI columns. The SMC is the critical galaxy in which to study the strong 2175 Å extinction bump as the this galaxy shows sightlines with and without this feature. This proposal will increase the number of sightlines in the SMC with high quality extinction curves showing a obvious 2175 Å bump from one to three. The sightlines proposed here were previously observed by Maiz Apellaniz & Rubio (2012) at very low resolution in the mid-UV using STIS slitless prism observations in a 25"x25" region centered on a known molecular cloud. They found two sightlines to having obvious 2175 Å bumps and two sightlines with very weak to absent bumps. New observations are needed to improve the details of the mid-UV extinction curve (e.g. 2175 Å bump centroid), measure the far-UV extinction curve, and measure the HI columns. We will combine these four new high quality extinction curves with the existing 16 SMC curves and use this enhanced sample to study environmental factors that influence the presence of the 2175 Å bump (e.g., gas-to-dust ratio, PAH grain mass fraction, & radiation field).

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14226

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14226  
Program Title: Stellar Forensics VII: A post-explosion view of the progenitors of core-collapse supernovae  
  
Principal Investigator: Justyn Maund  
  
PI Institution: University of Sheffield

Recent studies have used high spatial resolution HST observations of supernova (SN) sites to directly identify the progenitors of core-collapse SNe on pre-explosion images. These studies have set constraints about the nature of massive stars and their evolution just prior to their explosion as SNe. Now, at late-times when the SNe have faded sufficiently, it is possible to return to the sites of these core-collapse SNe to search for clues about the nature of their progenitors.

We request time to conduct deep, late-time, high-resolution imaging with ACS WFC of the site of the core-collapse SN 2012ec. We aim to: 1) Confirm our original identification, made in pre-explosion HST images, by confirming that the progenitor is now missing; 2) Apply image subtraction techniques for this late-time imaging with our pre-explosion images to determine accurate photometry of the progenitor to constrain its temperature and luminosity; and 3) use the stellar population in the immediate vicinity of the SN to determine the reddening and extinction that affected the progenitor. HST provides the unique combination of high-resolution optical/IR imaging at very faint magnitudes that will facilitate this study.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14227

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14227  
Program Title: The CANDELS Lyman-alpha Emission At Reionization (CLEAR) Experiment

Principal Investigator: Casey Papovich

PI Institution: Texas A & M University

One of the most promising probes of reionization is the evolution of Ly-alpha emission from galaxies at  $z > 6.5$ . We propose to measure the evolution of the strength of Ly-alpha emission in galaxies at  $z = 6.5-8.2$  using 16 pointings to 12 orbit depth with the WFC3/G102 grism in the deep CANDELS fields (including 4 pointings with existing data). The data will be sensitive to low line fluxes, and rest-frame Ly-alpha equivalent widths as low as 40-60 Angstroms for galaxies at  $H(AB) = 27$  mag. By targeting in CANDELS, our objects have the highest quality dataset of any fields on the sky, which provides high-redshift galaxy samples with the highest fidelity and enables the efficient rejection of contaminants. A clear advantage of the G102 grism over ground-based telescopes is that it provides stable image quality and a smooth sensitivity function over the wavelength range, 0.85-1.15 micron (without terrestrial effects of night sky lines), covering Ly-alpha from all galaxies with  $z = 6$  to 8.2. Our survey will provide spectroscopic observations of Ly-alpha in 90 (105) star-forming galaxies with  $z = 7-8.2$  (6.5-7.0), making it the largest, deepest, homogeneous survey of its kind and quadrupling the area in CANDELS covered with deep G102 spectroscopy. Our proposal goals are: 1. Provide spectroscopic redshifts for hundreds of  $z = 1-8$  galaxies fainter than ground based limits (including 90 at  $z > 7$ ); 2. Provide the most robust measurement yet of the Ly-alpha detection fraction and its evolution for galaxies at these redshifts; 3. Measure the evolution of the Ly-alpha distribution function and discern between models of the evolution of Ly-alpha emission.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14228

Proposal Category: GO  
Scientific Category: ISM and Circumstellar Matter  
ID: 14228  
Program Title: Thermal Equilibration and Cosmic-Ray Acceleration in Astrophysical Shocks: UV Spectra of the SN1006 Remnant

Principal Investigator: John Raymond  
PI Institution: Smithsonian Institution Astrophysical Observatory

Two outstanding questions about the physics of interstellar shock waves are 1) the degree of thermal equilibration among electrons and different ions and 2) efficiency of transfer of energy from the thermal plasma to energetic particles—cosmic rays. Those questions are closely related in that both processes depend upon plasma turbulence in the shock. The degree of thermal equilibration is also important for diagnostics of shock speed based on measured electron or proton temperatures.

We propose to observe a fast shock in SN1006 to measure the kinetic temperatures of He, C and N from the widths of the He II, C IV and N V line profiles. It is known from HUT and FUSE observations that the plasma behind a 2300 km/s shocks in SN1006 is far from equilibrium, with He, C and O temperatures roughly mass-proportional (4, 12 and 16 times the proton temperature, respectively), rather than approximately equal to the proton temperature as full equilibration would dictate. By contrast, the He and C temperatures ARE close to equilibrium with the protons in a 350 km/s shock in the Cygnus Loop. However, the existing measurements for SN1006 are quite uncertain, and only one other measurement of ion temperatures in a fast collisionless shock exists. The proposed observation will tighten the constraints on thermal equilibration by factors of 4 to 6.

SN1006 is the only Galactic SNR with fast shocks and low enough reddening to be observable in the UV, and we have identified a filament twice as bright and 25% faster than the region studied previously. Thus spectroscopy with COS provides a unique opportunity to attack this problem.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14229

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14229  
Program Title: Characterizing a Magnetic CV Associated with a PNe via COS UV Spectroscopy

Principal Investigator: Mark Reynolds

PI Institution: University of Michigan

Cataclysmic variables (CVs) are the most abundant class of X-ray binary system. We have recently discovered a new CV that is consistent with the position of a known planetary nebula. The discovery of a compact binary system in a planetary nebula comes with the promise of insight into common envelope physics and SN Ia progenitors if the binary mass is greater than Chandrasekhar. Herein, we propose to obtain 2 orbits of HST/COS FUV moderate resolution spectroscopy to further characterize this intriguing binary system. The requested science exposure will enable the first constraints to be placed on the FUV emission, including the potential emission from the WD and the truncated accretion disk.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14230

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14230  
Program Title: The Ultimate Emission Line Diagnostics Study at  $z=1.4$

Principal Investigator: Jane Rigby

PI Institution: NASA Goddard Space Flight Center

We propose the ultimate WFC3 grism spectroscopy, in terms of spatial resolution, signal-to-noise ratio, and diagnostic emission line coverage, at  $z=1.4$ . The targets are two extremely bright lensed galaxies at redshifts of 1.329 and 1.420. These redshifts place all of rest-frame optical diagnostic emission lines, from [O II] 3727 to [S II] 6731 Å, in the WFC3 G102 and G141 grisms. On spatial scales down to 100~pc, we will map the star formation rate, metallicity, extinction, and excitation across these two galaxies, and thereby measure not only the physical conditions of star formation, but how those conditions vary spatially. For the target that currently lacks HST and Spitzer imaging, we propose 2 orbits of WFC3/UVIS imaging to enable creation of a lensing map, and 1~hr of Spitzer to obtain a stellar mass estimate. This program will be a legacy for HST, the most rigorous in situ test yet of strong-line nebular line diagnostics in the distant universe, and will establish a benchmark for far larger grism surveys in which HST has invested some 700 orbits.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14231

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14231  
Program Title: The First Detections of Phosphorus, Sulphur, and Zinc in a Bona-Fide Second-Generation Star

Principal Investigator: Ian Roederer

PI Institution: University of Michigan

We propose to obtain new NUV COS spectra of the bright carbon-enhanced metal-poor star BD+44 493. This extremely low-metallicity ( $[Fe/H] = -3.8$ ) star exhibits the chemical signature expected for a second-generation star that formed from the metals produced by a single zero-metallicity Population III star. Our group has previously studied the detailed abundance pattern of this star from NUV and optical spectra (2300-9350 Angstroms). Now we propose to obtain new high-resolution spectra of this star extending to 1800 Angstroms. These observations would allow us to detect three elements that have not been studied previously in BD+44 493, or any other CEMP star with  $[Fe/H] < -4$ : phosphorus, sulphur, and zinc. Our proposed observations will constrain the abundances of these elements, and test the predictions of models for at least one of the likely zero-metallicity supernova progenitors that may have existed in the early Universe.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14232

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14232  
Program Title: STIS Observations of Metal-Poor Stars: Direct Confrontation with Nucleosynthetic Predictions  
  
Principal Investigator: Ian Roederer  
  
PI Institution: University of Michigan

We propose to obtain STIS NUV echelle spectra (2300-3100 Angstroms) of three extremely metal-poor ( $[Fe/H] \sim -3$ ) main-sequence turnoff stars. We will analyze these spectra to obtain accurate elemental abundances from many transitions of neutral and singly-ionized species of Fe-group elements (Sc, Ti, V, Cr, Mn, Fe, Co, Ni; atomic numbers 21 to 28). Relative abundances of this element group can be predicted theoretically in detail, and they can be interpreted in terms of stellar nucleosynthesis and Galactic chemical evolution. However, their observed abundances in low-metallicity stars are unreliable at present, and there are substantial clashes with theoretical predictions. Our proposed observations, built on a solid foundation of recent and new laboratory transition studies by our group, will finally provide reliable Fe-group abundances that can at last directly confront the Galactic chemical evolution predictions for these important elements.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14233

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14233  
Program Title: Taming the Tepid Three

Principal Investigator: Adam Schneider

PI Institution: University of Toledo

With atmospheric conditions similar to those of the Solar System giant planets, cold ( $T_{\text{eff}} < 700$  K) brown dwarfs are excellent proxies with which to test the ultracool model atmospheres that are critical to our understanding of gas giant exoplanets. A complete census of these objects is also essential for measuring the low-mass stellar mass function and the low-mass limit of star formation. The three coldest known brown dwarfs (WISE 1828+2650, WD 0806-661B, and WISE 0855-0714) all have effective temperature estimates of less than approximately 300 K. Previous HST and Spitzer observations of WISE 1828+2650 and WD 0806-661B provide near complete coverage of the 1 to 5 micron wavelength range. Unfortunately, the coldest of the three, WISE 0855-0714, has yet to be securely detected at near-infrared wavelengths which limits our ability to precisely measure many of its basic properties. We therefore propose to obtain near-infrared photometry of WISE 0855-0714 with WFC3 with the F105W, F125W, and F160W filters. These observations will complete HST's reconnaissance of the tepid three and, when combined with published Spitzer photometry, will allow us to compute a more precise estimate of its effective temperature and search for the presence of water clouds in its atmosphere.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14234

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14234  
Program Title: The Lowest Luminosity Star-Forming Galaxy

Principal Investigator: Joshua Simon

PI Institution: Carnegie Institution of Washington

We propose ACS/WFC imaging of the newly discovered Milky Way satellite galaxy Eridanus II. Eri II is unique among nearby dwarfs in that it appears to contain young stars but has no detected gas, and it is located just beyond the transition radius around the Milky Way inside of which star formation is rapidly quenched. With a luminosity of only 54000  $L_{\text{sun}}$ , Eri II is likely the lowest luminosity star-forming galaxy yet found, surpassing Leo T. This combination of properties makes Eri II a key target for studying the mechanisms by which low-mass galaxies are quenched, and it will provide new insight into why some dwarfs are able to continue forming stars for a Hubble time while other seemingly similar objects are not. We will use a deep HST color-magnitude diagram to derive the star formation history of the galaxy, confirming the existence of its young population, measuring the age of its oldest stars, and determining whether its star formation has been continuous or episodic.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14235

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14235  
Program Title: Globular Cluster Orbits from HST Proper Motions: Constraining the Formation and Mass of the Milky Way Halo  
Principal Investigator: Sangmo Sohn  
PI Institution: The Johns Hopkins University

The globular cluster (GC) system of the Milky Way (MW) provides important information on the MW's present structure and past evolution. GCs in the halo are particularly useful tracers; because of their long dynamical timescales, their orbits retain imprints of their origin or accretion history. Full 3D motions are required to calculate past orbits. While most GCs have known line of sight velocities, accurate proper motion (PM) measurements are available for only a few halo GCs. We will create the first high-quality PM database for halo GCs. We have identified suitable 1st-epoch data in the HST Archive for 20 halo GCs at 10-100 kpc from the Galactic Center. We propose to obtain the necessary 2nd-epoch data to determine absolute PMs, using distant background galaxies as stationary reference sources. We will use the same advanced astrometric techniques that allowed us to measure the PMs of M31 and Leo I. Previous studies of the halo GC system based on e.g., stellar populations, metallicities, RR Lyrae properties, and structural properties have revealed a dichotomy between old and young halo GCs. This may reflect distinct formation scenarios (in situ vs. accreted). Orbit calculations based on our PMs will directly test this. The PMs will also yield the best handle yet on the velocity anisotropy profile of any tracer population in the halo. This will resolve the mass-anisotropy degeneracy to provide an improved estimate of the MW mass, which is at present poorly known. In summary, our proposed project will deliver the first accurate PMs for halo GCs, and will significantly increase our understanding of the formation, evolution, and mass of the MW.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14236

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14236  
Program Title: The First Proper Motions of Ultra-faint Dwarf Galaxies: Probing Reionization and Planar Associations of Satellites  
  
Principal Investigator: Sangmo Sohn  
  
PI Institution: The Johns Hopkins University

Ultra-faint dwarf (UFDs) galaxies are the least luminous, dark-matter dominated galaxies in our Universe. As potential fossil relics of the epoch of reionization, these extreme galaxies play a crucial role in reconciling predictions from LCDM theory, such as the observed number of satellites about our Milky Way (MW). However, none of these galaxies have measured proper motions (PMs), meaning we do not know their orbital histories or their relationship to other satellites over time. We propose to use HST ACS/WFC to make the first PM measurements for 6 UFDs with star formation histories suggesting quenching at the epoch of reionization. Using techniques we have developed to model the orbits of satellites like Leo I and the Magellanic Clouds, these PMs will constrain the orbital histories of a representative sample of UFDs for the first time. We will furthermore compare these orbits to predictions for UFDs from cosmological simulations made by our team. HST is significantly more accurate for PM measurements of our target galaxies than Gaia. Moreover, with HST we can do these measurements now, whereas the most accurate Gaia measurements are still 7 years into the future. With only a modest investment of HST time and proven techniques of our team, these novel HST observations will thus revolutionize our understanding of UFDs, establishing for the first time: (1) Whether star formation was suppressed by reionization; (2) Whether the UFDs ever passed close enough to the MW to have undergone significant tidal heating; and (3) Whether the UFDs orbit in a plane that is associated with the classical satellites.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14237

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14237  
Program Title: r-process kilonova emission accompanying short-duration GRBs

Principal Investigator: Nial Tanvir

PI Institution: University of Leicester

Our HST observations of the short-duration gamma-ray burst GRB130603B showed an infrared excess, about ten days after the burst, consistent with expectations from models of an emerging 'kilonova' driven by the radioactive decay of newly-synthesised r-process elements. This directly supports the compact object merger hypothesis for short-duration GRBs, in which dynamically ejected neutron star material powers a radioactive transient. If confirmed in future events, this discovery also provides empirical evidence for a new, quasi-isotropic, electromagnetic signature of the most promising class of gravitational wave (GW) sources for detection with the next generation of detectors, and suggests that kilonovae of this sort are likely sites of substantial (perhaps dominant) production of r-process elements in the universe. However, the ubiquity and range of behaviour of these events is entirely unknown. We need to establish their properties to inform searches of GW error boxes and quantify their contribution to the heavy element nucleosynthesis budget. Here we propose ToO observations of a low-redshift ( $z \sim 0.35$ ) SGRB localised during cycle 23 to search for and characterise more fully any similar accompanying kilonova signal.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14238

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14238  
Program Title: Identifying and studying gamma-ray bursts at very high redshifts

Principal Investigator: Nial Tanvir

PI Institution: University of Leicester

Gamma-ray bursts are bright enough to be seen to very great distances and their afterglows can provide redshifts and positions for their host galaxies, and in some cases details of the ISM and the IGM close to the burst, irrespective of the host magnitude itself. Thus GRBs, despite their small numbers, offer a unique and powerful tracer of early star formation and the galaxy populations in the era of reionization. Our efforts to identify high- $z$  GRBs have been rewarded with the discoveries of GRB 090423 and GRB 120923A at spectroscopic redshifts of 8.2 and 7.9 respectively. However, it remains the case that some good candidate high- $z$  GRBs cannot be followed up quickly or deeply enough with ground-based IR spectroscopy, and indeed for others the Ly-alpha break may fall in regions of the IR spectrum difficult to access from the ground. GRB 090429B is an example, which had a photo- $z$  of 9.4, but for which spectroscopy was curtailed due to bad weather. WFC3/IR on HST can obtain redshifts based on the location of the Ly-alpha break via slitless grism spectroscopy to considerably deeper limits (and hence later times) than is possible from the ground, thus offering a solution to this problem. This proposal aims to continue to build the sample of  $z > 7$  GRBs by obtaining spectroscopy for a candidate for which photometry suggests a very high redshift, but where the redshift could not be secured from the ground. We also propose to monitor the afterglow of up to one  $z > 7$  GRB found, to allow comparison with the lower redshift population of bursts, and to perform an initial search for its host. The low rate of  $z > 7$  GRBs leads us to request a long-term ToO program, spanning cycles 23 and 24.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14239

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14239  
Program Title: Direct Imaging of Galactic Winds in Extreme Starburst Galaxies

Principal Investigator: Christy Tremonti

PI Institution: University of Wisconsin - Madison

Without strong feedback and efficient quenching of star formation, it is impossible for numerical simulations to reproduce a realistic galaxy population. To understand how this feedback process works, a crucial parameter that observations can constrain is the mass ejected in galactic winds. Unfortunately, there are order-of-magnitude uncertainties associated with estimates of mass outflow rates, particularly for winds that are detected via blueshifted absorption lines towards distant star-forming galaxies. This is primarily because the geometry and spatial extent of the wind cannot be measured directly and the inferred mass outflow rate scales as  $r_{\text{wind}}^2$ . One promising technique is to search for extended emission associated with resonantly scattered line photons from the wind. In practice, this is quite difficult to do with ground-based observations, which lack the required sensitivity and spatial resolution. Here we propose to use the unique medium-band imaging capabilities of HST to directly image the winds associated with two massive galaxies at  $z=0.6$  that have recently experienced a feedback-limited starburst and are known to exhibit high-velocity, galactic scale outflows. We will measure (or place robust limits on) the geometry and spatial extent of these galactic winds as traced by resonantly scattered Mg II photons. This provides a unique opportunity to measure the mass outflow rate and energetics of these powerful winds and to quantify their role in the quenching of star formation.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14240

Proposal Category: GO  
Scientific Category: ISM in External Galaxies  
ID: 14240  
Program Title: Mapping the circumgalactic medium of two large spiral galaxies

Principal Investigator: Bart Wakker

PI Institution: University of Wisconsin - Madison

The distribution and kinematics of the gas flows around galaxies provide important observational constraints on models of structure formation and galaxy formation/evolution. Current observational constraints on the motions, density and ionization of material around galaxies are based on ensembles consisting of many single sightlines crossing halos of individual galaxies of different types, masses and orientations. One of the original goals set for COS was to take the next step: mapping the gas around a single galaxy using multiple sightlines, to get around the biases affecting ensemble studies. We propose a 28-orbit observing program to obtain COS G130M spectra of 9 quasars that sample HI at  $\log N(\text{HI}) = 13-15$  in the circumgalactic medium of the nearby isolated edge-on  $\sim 3 L^*$  spiral NGC2770 and the nearby, isolated face-on  $\sim 2.5 L^*$  spiral NGC3631, at impact parameters of  $\sim 200$  to  $400$  kpc ( $0.7-1.5$  times the virial radius). We will determine the column densities, kinematics and line widths of HI Ly $\alpha$  as function of impact parameter, without confounding factors due to mixing different galaxies. We will compare these measurements with results of cosmological simulations of similar-sized galaxies, providing a unique view of the density structure of and large-scale gas flows around isolated, large spirals.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14241

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14241  
Program Title: Cloud Atlas: Vertical Cloud Structure and Gravity in Exoplanet and Brown Dwarf Atmospheres  
Principal Investigator: Daniel Apai  
PI Institution: University of Arizona

Condensate clouds play a fundamental role in all three types of substellar ultracool atmospheres: transiting planets, directly imaged exoplanets, and brown dwarfs. The primary parameter influencing the spectra of these atmospheres is temperature, but observations demonstrate the presence of a second key parameter. It is often assumed, but not verified, that the second parameter is surface gravity. We pioneered HST rotational phase mapping of brown dwarfs and exoplanets, providing new insights in the heterogeneity, longitudinal and vertical structure, and dynamical evolution of condensate clouds on a small set of targets. We propose a high-precision HST/WFC3 Treasury survey to answer the question: What is the effect of gravity on cloud structure in ultracool atmospheres? We will derive full-rotational longitudinal and vertical cloud maps for 10 brown dwarfs and exoplanets to sample their atmospheres. By probing the variability amplitude in J-, H-, and 1.4-micron water absorption bands we will test model predictions on the connection between gravity, temperature, and vertical cloud structure. The observations will provide a homogeneous and uniquely rich set of longitudinal vertical cloud maps of 10 ultracool atmospheres (including brown dwarfs and planetary mass companions) and complement 6 brown dwarfs observed in previous studies, which will enable new, powerful comparative atmospheric studies, including cloud tomography. We will apply a novel technique unique to HST to address a question fundamental to the atmospheres of transiting planets, directly imaged exoplanets, and brown dwarfs. Our survey will result in an information-rich data set with very high legacy value.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14242

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14242  
Program Title: Deep Multiwavelength Campaign on an AGN Outflow: Absolute Abundances and the Warm Absorber Connection  
  
Principal Investigator: Nahum Arav  
  
PI Institution: Virginia Polytechnic Institute and State University

Our team was recently awarded a deep multiwavelength campaign on the AGN outflow seen in the Seyfert 1 galaxy NGC 7469: 560 ks on XMM, 140 ks NuSTAR observations, 80 ks Swift, 14 HST/COS orbits (covering 1135A - 1700A), and optical ground-based monitoring. The missing piece in our campaign is the ability to measure absolute abundances, which are crucial for determining the ionization equilibrium and kinetic luminosity of the outflow. Here we propose to obtain near-simultaneous HST/COS spectra of the 940A-1100A range covering the Lyman beta, gamma and delta lines, which are needed for abundance determination. This will reduce the uncertainties on the ionization equilibrium and kinetic luminosity by an order of magnitude. These observations also cover the O VI doublet that allows us to connect the X-ray warm absorber with the UV outflow.

AGN Outflows play a crucial role in feedback processes that control galaxy evolution, the growth of central black holes in galaxies, and the enrichment of the ICM and the IGM. Our research collaboration achieved unprecedented scientific results from two similarly large campaigns on Mrk 509 and NGC 5548. Besides the deep coverage of many spectral regions, we also cover the time domain, which is crucial for determining the distance of the bulk of the outflow from the central source.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14243

Proposal Category: GO  
Scientific Category: ISM and Circumstellar Matter  
ID: 14243  
Program Title: True Jet Rotation Probed in NUV Jet Core

Principal Investigator: Deirdre Coffey

PI Institution: University College Dublin

Recent observations searching for jet rotation in newly forming stars have the potential to support theories of magneto-centrifugal jet launching. However, whether or not we can claim to observe jet rotation has been hotly debated. Past HST studies have revealed differences across the radial velocity profile of the jet close to the base, but subsequent observations and simulations suggest the outer layers of the jet may be disrupted by shocks or instabilities. On the other hand, the jet core, which is probed at NUV wavelengths, may be protected from these contaminations by the outer jet layers. This idea is supported so far by the fact that the NUV jet rotation direction matches the disk rotation direction in 2 of 2 cases examined. This seems to suggest that NUV data is the only real window on jet rotation, where the signature is not disrupted by other kinematic signatures that may be present in other wavelength regimes. Indeed IR IFU data reveal that the jet kinematics are not simple, and that IFU-style observations are critical in interpreting potential jet rotation signatures. Therefore, we propose STIS/MAMA observations to investigate the jet rotation signature of the jet core in 3 targets. We will map these observations to existing IFU and other data to aid interpretation. Targets are chosen because the sense of disk rotation is already known, and so we can have a definitive answer as to whether we have full agreement in jet and disk rotation sense for the NUV jet core.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14244

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14244  
Program Title: Possible Stellar Donor or Remnant for the Type Iax SN 2008ha

Principal Investigator: Ryan Foley

PI Institution: University of Illinois at Urbana - Champaign

White dwarf (WD) supernovae (SN) play a pivotal role in astrophysics, but are surprisingly poorly understood. We now know that not all exploding WDs are SN Ia. Some are SN Iax: low-energy stellar explosions that are similar to, but physically distinct from, SN Ia. Recent deep HST pre-explosion images reveal a blue source at the position of a SN Iax. This is the first detection of the progenitor system for a WD SN! Our favored interpretation is that this source is the helium star binary companion to the progenitor WD.

Observations suggest, and theory predicts, that some SN Iax do not completely disrupt their WD progenitor stars, leaving behind a battered, bruised, and possibly very luminous remnant. In Cycle 20, we imaged the location of a nearby SN Iax, SN 2008ha, 4 years after explosion, and detected a luminous red source, S1, at the position of the SN. S1 could be (1) the companion star, possibly affected by the SN impact, (2) the luminous remnant star, which would be the first time such an object has ever been detected, or (3) a chance coincidence (although unlikely, it is not completely ruled out).

A companion or remnant star is predicted to vary on years timescales, while an unrelated star should not vary. Basic assumptions suggest that a companion would brighten and a remnant would fade between our last observations and now. We propose to observe S1 with HST to measure its possible variability and distinguish between the possible scenarios.

These measurements will result in deeper understanding of SN Iax, and all WD SN, and possibly reveal the second

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14245

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14245  
Program Title: The winds of the most Fe-poor massive stars of the Local Group: Sextans-A

Principal Investigator: Miriam Garcia

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

Radiation driven winds (RDWs) dominate the lives of massive stars and are a key ingredient of current calculations for their evolution and feedback. Their strong metallicity dependency has been positively tested with Milky Way, LMC and SMC stars. However, the  $0.2Z_{\text{sun}}$  frontier set by the SMC must be crossed before the theoretical prescriptions can be extrapolated to the early Universe. Recent studies that targeted Local Group oxygen-poor irregular galaxies to this aim were futile, as later on these systems were found to have an SMC-like content of iron. The outcome is that RDW theory is still to be tested in genuinely iron-poor environments.

We request low resolution COS FUV spectra of resolved OB stars in Sextans-A, the most iron-poor galaxy of the Local Group with  $0.1Z_{\text{sun}}$  or smaller. The resulting dataset will allow us to characterize the winds of truly iron-poor massive stars.

The crucial role of UV spectroscopy to characterize RDWs at low metallicity cannot be overstated: it is the best and in most cases only provider of diagnostics for the wind terminal velocity in the entire electromagnetic spectrum, and contains sensitive enough lines to constrain mass loss rates and iron content. This proposal builds on the team's previous experience on HST-COS observations of resolved OB stars beyond the SMC.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14246

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14246  
Program Title: The Fastest Rotating Stars

Principal Investigator: Douglas Gies

PI Institution: Georgia State University Research Foundation

The VLT FLAMES Survey of the massive stars in the Tarantula Nebula region of the LMC has led to the discovery of the two fastest rotating stars: VFTS 102 and 285 with  $V \sin i = 610$  and  $609$  km/sec. These two O-dwarfs may be single stars born with extraordinarily high angular momentum or they may have been spun up in a binary system by mass transfer or merger. Extreme rotators like these suffer gravity darkening that makes their equatorial regions cooler than the polar zones, so that the equatorial parts close to the limb contribute less flux and create narrower lines. We show how HST/COS spectroscopy of the far-ultraviolet spectra can be used with the optical rotational line broadening to estimate this gravity darkening effect and to determine the ratios of equatorial to critical rotation velocity for these two stars. This ratio is key to describing the bipolar winds of rapidly rotating stars, and the COS spectra will record the important wind lines in the FUV for comparison with models of asymmetric winds. The COS spectra will yield estimates of the stellar masses, radii, rotation rates, and abundances that will help us assess the origin and destiny of these remarkable stars in particular and massive rotating stars in general.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14247

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14247  
Program Title: Confirmation of an Intermediate-Mass Black Hole in an Extragalactic Globular Cluster

Principal Investigator: Jimmy Irwin

PI Institution: University of Alabama

The long and controversial search for black holes within globular clusters has reached the point where extragalactic globular clusters provide fertile hunting grounds for finding black holes of both stellar and intermediate-mass (IMBH) varieties. While a luminous X-ray point source within a cluster can indicate the presence of a black hole, little can generally be said of its mass without further observation. In the event that a black hole tidally disrupts a passing star in the cluster, optical/UV emission lines from the X-ray-illuminated debris can not only demonstrate the existence of a black hole in the cluster, but can also provide powerful constraints on the mass of the black hole, the composition of the disrupted star, and even the time since the tidal disruption event took place. We propose an HST COS G140L UV spectrum of a globular cluster within the Fornax elliptical galaxy NGC1399 that exhibits unusual optical [N II] and [O III] forbidden emission lines that are believed to result from such a tidal disruption event by a ~100 solar mass black hole. Our models predict that the ratios of the expected emission lines from carbon, nitrogen, and oxygen that should be present in the UV spectrum of the source will be able to distinguish a stellar-mass black hole from an IMBH as the disruptor, as well as determine the nature of the disrupted star. If the mass of the black hole is constrained to be in excess of 100 solar masses, this would provide one of the most compelling pieces of evidence to date that IMBHs exist within globular clusters.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14248

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14248  
Program Title: Studying Dual AGN Activity in the Final Merger Stage

Principal Investigator: Michael Koss

PI Institution: Eidgenossische Technische Hochschule (ETH)

During the process of merging, close dual AGN, with two growing SMBHs hosted by a pair of merging galaxies, are predicted. Simulations further suggest that the highest levels of merger induced dual AGN activity occur on kpc scales where the high resolution of HST is required. While the theoretical model is clear, recent observational studies testing the merger driven AGN model have dramatically different scenarios and contradictory results. We have recently found a very high fraction of narrow line BAT detected QSOs (21%) showing hidden mergers ( $< 3$  kpc) only visible in adaptive optics. We propose HST STIS spectroscopic observations of a sample of four very close mergers (0.2-1.9 kpc) to study dual AGN triggering in this final stage of galaxy mergers. Our goals are to 1) confirm the nuclei as dual AGN and 2) measure the kinematics and ionization with high resolution along the slit to understand the merger. These observations will form part of a well-characterized legacy study of all 57 X-ray selected nearby AGN from the sky Swift-BAT in close major mergers ( $< 30$  kpc,  $z < 0.075$ ).

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14249

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14249  
Program Title: The old pulsar PSR J0108-1431, a key target to understand the long-term evolution of neutron stars  
Principal Investigator: Roberto Mignani  
PI Institution: INAF, Istituto di Astrofisica Spaziale e Fisica

The multi-wavelength study of >100 Myr old radio-pulsars holds the key to understanding the long-term evolution of neutron stars, including the advanced stages of the surface cooling history, and possible variations in the magnetosphere properties. Near-UV observations of neutron stars are particularly important for such studies because they offer the chance to explore both thermal and non-thermal emission processes. The first aim of this proposal is to obtain a robust detection of the candidate optical counterpart ( $U=26.4$ ) to the 166 Myr old radio pulsar PSR J0108-1431, discovered by us with the VLT, through WFC3/UVIS imaging in the U and B bands. The detection of a point source at the pulsar radio position, computed from its VLBI radio coordinates and proper motion, with U and B-band fluxes compatible with those of the candidate counterpart, will firmly secure our proposed identification. The second aim is to obtain the first measurement of the pulsar flux in the optical-UV with both the WFC3/UVIS and the ACS/SBC. This will enable us to determine the slope of the Rayleigh-Jeans continuum, only hinted in the VLT data, affected by large errors, and measure the temperature of the bulk of the neutron star surface, too cold to be detected in the X-rays where only hot polar caps have been detected with Chandra and XMM-Newton. The measured temperature will provide the crucial information to constrain neutron star cooling curves for ages >100 Myr, where theoretical predictions are highly uncertain, and from them verify different models of the neutron star interior.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14250

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14250  
Program Title: The ultraviolet light curve and spectrum of PSR B0540-69, the Crab Twin.

Principal Investigator: Roberto Mignani

PI Institution: INAF, Istituto di Astrofisica Spaziale e Fisica

Ten rotation-powered pulsars are firmly identified in the optical domain, the brightest of which is the Crab pulsar ( $V \sim 16.5$ ). The  $\sim 1700$  year old pulsar PSR B0540-69 in the LMC is considered the Crab pulsar twin because of its similar spin period and period derivative, hence similar inferred values of age, magnetic field, and spin-down energy, and is also one of the five pulsars for which optical pulsations have been detected. Strangely enough, however, although it is the second brightest pulsar ( $V \sim 22.5$ ) it is the only one of the five optical pulsars for which no search for UV pulsations has been ever carried out. Thus, it is the only one for which no information on its UV light curve is available. The UV spectrum of PSR B0540-69 is also unknown. Its optical/near-IR spectrum is fit by a power-law, like that of the other young rotation-powered pulsars. At variance with them, however, PSR B0540-69 features a unique double break in the optical-to-X-ray spectrum, with the first one most likely occurring in the UV. We propose to perform time-resolved imaging of PSR B0540-69 with the STIS NUV and FUV MAMAs to determine, for the first time, both the slope of its power-law spectrum and its light curve profile in the UV. This will enable us both to search for the expected spectral break in the UV and determine whether this is associated with a different pulsar emission geometry in the UV with respect to the optical by comparing the pulsar UV and optical light curves. This information is crucial to track the location of optical and UV emission regions in the neutron star magnetosphere, and compare them with the predictions of different emission models.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14251

Proposal Category: SNAP  
Scientific Category: AGN/Quasars  
ID: 14251  
Program Title: The Structures of Dwarf Galaxies Hosting Massive Black Holes

Principal Investigator: Amy Reines

PI Institution: University of Michigan

Present-day dwarf galaxies hosting massive black holes (BHs), while apparently rare, are currently our best observational probes of the origin of BH seeds. We have systematically assembled the first and largest sample of dwarf galaxies hosting active BHs using optical spectroscopy from the SDSS (Reines et al. 2013). However, we know very little about the structures of the host galaxies (e.g, if they have bulges) and how they compare to the general population of dwarf galaxies of comparable mass. Here we propose WFC3/IR SNAPshot observations of a subsample of 61 objects from our SDSS sample that are the best cases for dwarf galaxies hosting massive BHs. With the proposed observations, we will 1) characterize the structural properties of the host galaxies, and 2) compare our results to a control sample of non-AGN hosting dwarf galaxies and more massive AGN hosts. This work will provide valuable constraints on the host galaxies of BH seeds, and place rare AGN-hosting dwarf galaxies in the broader context of galaxy and BH evolution.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14252

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14252  
Program Title: Environmental signatures on galaxy populations in the most massive clusters at  $z \sim 1.5$   
Principal Investigator: Veronica Strazzullo  
PI Institution: Universitats-Sternwarte Munchen

We propose to obtain ACS/F814W and WFC3/F140W imaging of a complete sample of the five highest redshift clusters discovered in the SPT-SZ survey. This will enable a first uniform statistical study of galaxy populations in the most massive structures at  $z > 1.4$ . This redshift is a crucial transition time for massive galaxies in cluster environments. It bridges the major star formation events at  $z \sim 2$  that built most of the stars in massive cluster early-types, and the  $z \sim 1$  regime largely characterized by passive evolution in cluster cores. Massive clusters at this time are still very rare. Cluster galaxies at this redshift have thus been investigated in only a handful of clusters selected in different ways that may well bias galaxy population studies. As an important next step beyond these initial studies, this project explores central questions that still remain controversial: How efficient is quenching of star formation in the most massive structures at  $z \sim 1.5$ ? How common are highly star-forming galaxies in the densest cluster-core environments? What are the morphologies of massive cluster galaxies, and how different is their structural evolution in clusters and in the field? How is the link between old stellar populations and bulge-dominated structure established so early? Answering these questions requires deep high-resolution observations to probe stellar populations and morphologies, and a statistically significant, unbiased, uniform sample of cluster galaxies in very massive structures, where environmental signatures are expected to be more evident. The combination of HST capabilities with a unique cluster sample now allows a first, timely and necessary step forward.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14253

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14253  
Program Title: Verifying the progenitor identification of the type II-P supernova 2009ib

Principal Investigator: Katalin Takats

PI Institution: Universidad Andres Bello

There have been several examples where archival HST images were used to directly identify the progenitor of a supernova (SN), but only a handful of cases were published, where the identification was confirmed by taking HST imaging after the SN faded. We propose such late time observations to revisit the field of the type II-P SN 2009ib and obtain deep, high resolution images with WFC3 UVIS. In the pre-explosion images a yellow source was visible at the position of the SN, even though so far the progenitors of SNe II-P have been found to be red supergiant stars. There are several scenarios that can explain the detection, including the superposition of multiple sources or a compact cluster. With the proposed observations we will be able to decide among the scenarios, as well as constrain the luminosity and the initial mass of the progenitor and study the immediate environment of the SN.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14254

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14254  
Program Title: Accurate cosmography from gravitational time delays: 2.3% on  $H_0$  from deep WFC3 images of lensed quasars  
Principal Investigator: Tommaso Treu  
PI Institution: University of California - Los Angeles

The combination of precise distance measurements at low redshift ( $z < 1$ ) with cosmic microwave background (CMB) data provides the most powerful constraints on the dark energy equation of state parameter  $w$ , spatial curvature, and neutrino physics. Our team has demonstrated that a single gravitational lens can be used to measure time-delay distances to 5% precision and accuracy, i.e. including systematic errors. This requires deep HST images - necessary to measure accurately the gravitational potential of the deflector galaxy - in addition to ground based determinations of the time-delay (from COSMOGRAIL), and the redshift and velocity dispersion of the deflector obtained at Keck and VLT. We propose to take a major step toward a 1% determination of the Hubble constant  $H_0$  independent of the local distance ladder and the CMB by imaging 4 carefully selected gravitational lens systems with WFC3. This proposal doubles the number of suitable systems for this analysis thus achieving 2.3% equivalent precision on  $H_0$ . Combining time-delays with Planck or WMAP9 data yields

0.4% precision on flatness and  $< 0.10$  on  $w$ , independent of any other probe. As in our previous work, we will analyze each system independently and blindly, thus avoiding confirmation bias, and using the scatter between systems to test for unknown residual systematic uncertainties. In addition to its immediate deliverable result, this proposal will quadruple the number of doubly lensed quasars with deep images of the extended source. With hundreds of doubles to be discovered by upcoming surveys, detailed studies of doubles pave the way for a 1% determination of  $H_0$  based only on time-delays.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14255

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14255  
Program Title: A First Look at the Late Stages of Accretion in Tidal Disruption Flares

Principal Investigator: Sjoert van Velzen

PI Institution: The Johns Hopkins University

A star that passes too close to a supermassive black hole will be disrupted by the black hole's tidal gravity. The result is an electromagnetic flare that can outshine the optical luminosity of the host galaxy for a few months. The return rate of stellar debris decreases from highly super-Eddington to sub-Eddington in a few years, making stellar tidal disruptions flares (TDFs) a unique laboratory to study accretion physics. Synoptic surveys have so far yielded about 10 strong TDF candidates, and many more (10-100 per month) can be discovered by ongoing and near-future surveys. So far we have only observed the optical/UV emission in the first  $\sim 100$  days after the discovered event. The luminosity of this emission is too large to be produced in a compact accretion disk, and instead likely originates from  $\sim 100$ s- $1000$ s of gravitational radii from the black hole. After a few years, however, these outer regions will cool significantly, allowing us to directly observe the inner disk with short wavelength observations. Even in the most pessimistic scenario, the flux is readily detected at FUV wavelengths in  $\sim 1$  HST orbit. Here we propose HST ACS/SBC observations to measure the luminosity and temperature of newly formed accretion disks in a carefully selected sample of 8 known TDFs. These would be the first observations of late-time disk emission from tidal flares, greatly increasing our currently limited understanding of TDF emission mechanisms. In a broader sense, these observations might prove essential to fully realize the potential of TDFs as general tools in the era of time-domain astronomy.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14256

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14256  
Program Title: High-Precision Proper Motions in the M87 Jet

Principal Investigator: John Biretta

PI Institution: Space Telescope Science Institute

As the nearest galaxy with an optical jet, M87 affords an unparalleled opportunity to study extragalactic jet phenomena at the highest resolution. We have previously obtained HST images of the jet with unprecedented resolution which show detailed shock structures as well as numerous unresolved condensations over the first few arcseconds of the jet. Our previous HST monitoring observations have found superluminal motion at speeds up to  $6c$  in many of these features, and showed the formation of new emission regions and rapid variability.

The STIS/NUV instrument presents a unique opportunity to measure proper motions in the M87 jet with a single highly stable, high resolution detector across a 19 yr timebase. We will use these new data, together with existing STIS/NUV data, to map the velocity field of the jet with much higher accuracy than previously possible. This will allow us to measure the bulk deceleration of the jet, transverse motions, accelerations / decelerations of individual features, and numerous fainter jet features. We will use this to test models for the structure and kinematics of relativistic jet flows, synchrotron emission regions, and AGN in general.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14257

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14257  
Program Title: Far UV spectroscopic measurements of the deuterium abundance of comets

Principal Investigator: Dennis Bodewits

PI Institution: University of Maryland

We propose to use STIS Echelle spectroscopy to measure the deuterium to hydrogen ratio in two ToO comets to investigate the origin of their water ice. The deuterium abundance of water in comets preserves information about the formation conditions of our solar system, while also constraining the possible contribution of cometary water to Earth's oceans. The D/H values in JF comets and the ice ratios (CO/CO<sub>2</sub>/H<sub>2</sub>O) in both Jupiter Family and Oort Cloud comets call into question the details of the dynamical processes for populating the modern reservoirs for these two dynamical classes. However, currently too few D/H ratios have been measured in comets to allow for a meaningful interpretation. With a dedicated observing campaign we will measure the ratio between Ly-alpha emission from deuterium and hydrogen atoms from two different comets. We have defined strict conditions that ensure the quality of our measurement which we will use to trigger our ToO request. HST is essential for these observations as it is the only telescope that has the spectroscopic capabilities in the Far ultraviolet that is needed for these measurements.



Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14258

Proposal Category: GO  
Scientific Category: Cool Stars  
ID: 14258  
Program Title: The Nature of SPIRITS Mid-Infrared Extragalactic Transients

Principal Investigator: Howard Bond

PI Institution: The Pennsylvania State University

Our team is conducting a large-scale time-domain search for mid-infrared (MIR) transients in 194 nearby galaxies, using the warm Spitzer telescope. This program, called SPIRITS (SPitzer InfraRed Intensive Transients Survey) is underway now, and will continue throughout all of HST Cycle 23.

Among the astrophysical transients that we have found is a puzzling new class of luminous extragalactic MIR eruptions that lack conspicuous ground-based optical counterparts. They have MIR luminosities between those of novae and supernovae, and appear to be associated with spiral arms. Because of the lack of optical counterparts and of obvious progenitors, their exact nature is unclear. They have a wide range of eruption timescales, ranging from months to several years.

To explore their nature, we propose to obtain deep images of eight such events during Cycle 23, using WFC3 UVIS and IR observations. These will be non-disruptive Targets of Opportunity, with the exposures obtained about 4 weeks after the Spitzer discoveries. We will select transients that are at sites previously imaged by HST, so that we can look for progenitor objects, characterize the stellar populations at the outburst sites, and attempt to detect faint optical or near-IR counterparts at HST depth and resolution. By observing 8 events, we will sample their diverse range of outburst timescales, luminosities, and other properties.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14259

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14259  
Program Title: Resolved halo substructures beyond the Local Group: the assembly histories of NGC 253 and NGC 5128  
Principal Investigator: Denija Crnojevic  
PI Institution: Texas Tech University

We request HST/ACS imaging to follow up the 10 most prominent newly discovered substructures in the halos of NGC 253 and NGC 5128 (both at  $D=3.8$  Mpc, and the dominant galaxies of their respective groups, Sculptor and Centaurus A). The substructures were found via our ongoing ground-based (Magellan/Megacam) survey out to 150 kpc for each galaxy, and include stunning disrupting satellites, streams and shells. Current Cold Dark Matter based simulations provide testable predictions for the physical properties (e.g ages and metallicities) of in-situ/accreted components, but the lack of a robust observational census of outer halos for a wide range of galaxies beyond the Local Group prevents robust conclusions. Our proposed observations of the halo substructures in NGC 253 and NGC 5128 will confirm their distance, group membership, and allow for an accurate derivation of their luminosities, metallicities, and star formation histories: for the first time, substructures around Milky Way-sized halos beyond the Local Group will be characterized in great detail. The substructures' properties will be compared to those of the smooth halo, as derived from our wide-field imaging as well as from extant HST halo observations, and to similar substructures in the halos of the Milky Way and M31. This program will constitute a critical observational test to cosmological predictions of the hierarchical assembly process.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14260

Proposal Category: GO  
Scientific Category: Extra-Solar Planets  
ID: 14260  
Program Title: A Metallicity and Cloud Survey of Exoplanetary Atmospheres Prior to JWST

Principal Investigator: Drake Deming

PI Institution: University of Maryland

Planet formation models predict that the heavy element content of exoplanetary atmospheres reflects their region of formation and their accretion histories. In the Solar System, atmospheric metallicity appears to be inversely correlated with planet mass, but it is unclear whether or not this is a universal correlation. Bulk densities for transiting exoplanets are consistent with that observed trend, but the degree to which exoplanetary envelopes and atmospheres correlate with bulk densities is unknown. Moreover, the effect of mass loss by close-in planets on the evolution of their atmospheres is poorly understood. Clouds also appear to play an important role in exoplanetary atmospheres, but we know very little about their likely formation mechanisms or compositions. Because clouds obscure the expected atmospheric absorption signal during transit, we must develop an empirical understanding of the prevalence of clouds as a function of planetary temperature and surface gravity in order to enable the selection of cloud-free targets for future studies with HST and JWST. We will map the trends in cloud occurrence and metallicity for 16 exoplanets spanning 2 to 300 Earth masses, and temperatures from 500 to 2200 Kelvins. Our survey focuses on 1.4 micron water vapor absorption during transit, exploiting the high sensitivity that is now possible using WFC3 spatial scan mode.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14261

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14261  
Program Title: Post-Perihelion Imaging Polarimetry of the 67P/Churyumov-Gerasimenko with ACS:  
Continued Support of the Rosetta Mission

Principal Investigator: Dean Hines

PI Institution: Space Telescope Science Institute

We propose ACS/WFC imaging polarimetry of Comet 67P/Churyumov-Gerasimenko (hereafter 67P), in conjunction with the Rosetta mission, to place stringent constraints on dust particles in the coma. We will observe two epochs: 1) 2015-Oct, about two months after perihelion, when the comet is first accessible to HST and is expected to exhibit maximum activity; 2) 2016-Feb, the last opportunity during the present apparition to obtain polarimetry at the phase angle for which the polarization signature provides the most leverage on the dust composition. These new observations will be compared with our two previous (Cycle 22) epochs of pre-perihelion observations obtained just as Rosetta began its orbital phase and just after Philae had landed. This enables us to assess any changes in the dust properties caused by insolation during perihelion passage. The combined in-situ and remote pre- and post-perihelion observations will also help "calibrate" our interpretation of such observations, which will in turn inform our interpretation of future polarimetry observations of comets that cannot be visited by spacecraft. During the proposed observing epochs, 67P may only subtend 20 arcsec, so ground-based observations only provide about 5 "polarimetric resolution elements" across the coma. The HST/ACS provides around 40x better high spatial resolution. Laser AO systems provide higher spatial resolution, but do not have visible wavelength polarimetry modes, nor provide the very high precision and accuracy in the fractional polarization demonstrated with HST/ACS. HST is the only asset capable of achieving our objectives.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14262

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14262  
Program Title: Are the fastest growing black holes at  $z=2$  caused by major galaxy mergers?

Principal Investigator: Knud Jahnke

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

We will test whether at  $z=2$  highly accreting central supermassive black holes in galaxies are caused by major galaxy mergers. Though it has been shown in past years that mergers are not the main cause for the bulk of BHs at  $z<2$ , it is both possible and plausible that this can still be the case at the highest accretion rates. The targeted population ( $\log(M_{\text{BH}}/M_{\text{sun}})\sim 8.5$ ;  $L/L_{\text{Edd}}>70\%$ ) at  $z=2$  is the most directly accessible laboratory for the earlier Universe where QSOs are known to accrete near or above the Eddington limit, yet it is the most distant one for direct diagnostics of morphological major merging signs in the pre-JWST era.

We propose to observe 21 highly accreting QSOs at  $z\sim 2$  with  $L/L_{\text{Edd}}>70\%$  and analyse their host galaxy morphologies w.r.t. the incidence of strong distortions as proxy for recent or ongoing major galaxy merging. We will compare this with the strong distortion rate of  $>300$  inactive galaxies at same  $z$  and  $M^*$  from the publicly available CANDELS+ERS dataset. For this purpose we will remove the bright nucleus in the QSOs and mock up characteristic point source residuals in the centers of all inactive galaxies. A "blind" ranking of the distortion state of the combined two (host) galaxy samples based on a visual classification by at least 10 galaxy experts will allow to generate a bias-free statistic of merger fraction in both samples. Assuming a merger fraction of 20% for the inactive galaxies we will be able to detect an enhancement to at least 50% for QSOs at  $>99.7\%$  significance. If found, this would immediately imply that major merging is a significant or even dominating mechanism to fuel the highest accretion rate QSOs in the early Universe.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14263

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14263  
Program Title: Hubble Imaging of a Newly Discovered Active Asteroid

Principal Investigator: David Jewitt

PI Institution: University of California - Los Angeles

Active asteroid (aka main-belt comets or MBCs) have the orbital characteristics of asteroids but also show transient, comet-like activity caused by mass-loss. Examples of mass-loss likely caused by sublimation, impact, and rotational effects have been established, while numerous additional processes are capable of launching material from asteroids. We propose two orbits of non-disruptive, target-of-opportunity observations of any newly discovered active asteroid in cycle 23 in order to constrain the process driving the mass loss.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14264

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14264  
Program Title: A New Dual Perspective of Multi-phase Galaxy Outflows

Principal Investigator: Glenn Kacprzak

PI Institution: Swinburne University of Technology

We propose the first multi-phase outflow study of the only system where both a galaxy ( $z=0.2$ ) exhibits metal-line absorption back-illuminated by itself (down-the-barrel) AND transversely by a background quasar. The quasar sight-line is at a projected distance of 58 kpc along the galaxy minor axis; ideal orientation for outflows. We have already analyzed the outflow in the cool gas phase, traced by MgII absorption, in Kacprzak et al. (2014, ApJL,792,L12). Here we request 15 orbits to obtain COS/G130M spectra of BOTH the quasar and the galaxy to study the multi-phase outflows from two perspectives: down-the-barrel of the galaxy and at 58 kpc away probed by the quasar sight-line. We will probe the physics and kinematics of HI (full Lyman series), OVI, FeII, CIII, CII, NIII, and NII absorption from the galaxy and the quasar sight-lines. We will use our established models to further interpret the observed transverse gas-galaxy kinematics, spatial relationships, and ionization conditions, metallicities, outflow mass rates, loading factors and masses. Our proposed observations will provide the first dual multi-phase outflow analysis of its kind and will provide the community with a unique view into the physical properties and processes of gaseous outflows.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14265

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14265  
Program Title: Crossing the redshift desert: ionizing background radiation and intergalactic hydrogen at  $z \sim 1$   
Principal Investigator: Tae-Sun Kim  
PI Institution: INAF, Osservatorio Astronomico di Trieste

The intensity and spectral shape of the cosmic ionizing UV background radiation is important for understanding the physical state of the low-density,  $\sim 10^4$  K intergalactic medium (IGM) which is the dominant reservoir of the baryons at all cosmic epochs. Despite its importance, the UV background is still poorly constrained both observationally and theoretically, especially at  $z \sim 1$ , a crucial time in cosmic evolution where 1) very little observational information is currently available, 2) the claimed IGM evolution break based on low-quality data occurs, 3) the cosmic star formation rate and QSO number density decrease rapidly and 4) there exist no UV radiation background measurements. Given that the properties of neutral hydrogen in the IGM are sensitive to the UV background, we propose a 54-orbit program to obtain COS G225M spectra of 5 QSOs with high S/N ( $\sim 20$  per resolution element), in order to cover the IGM at  $z = 0.85$  to  $z = 1.07$ . High-S/N spectra enable direct profile fitting to the absorption lines, providing reliable HI column densities and line widths, and allowing deblending of metal lines. Direct comparisons with our Gadget-III cosmological simulations will be used to estimate the intensity and spectral shape of the UV background radiation and discriminate between the major IGM heating mechanisms at  $z = 1$ : photo-heating, galactic winds and blazars.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14266

Proposal Category: GO  
Scientific Category: Resolved Stellar Populations  
ID: 14266  
Program Title: Confirming NGC6946 BH1 - A Black Hole Formed in a Failed Supernova

Principal Investigator: C. Kochanek

PI Institution: The Ohio State University

There are good observational and theoretical reasons to believe that 10-30% of the core-collapses of massive stars lead to the formation of black holes without a supernova explosion. We have been carrying out the first observational search for such failed supernovae using the Large Binocular Telescope. From the first four years of the survey, we are left with one good candidate, NGC6946 BH1. Deep HST and SST observations are needed to better constrain the vanishing of this massive star than is possible from the ground. Confirmation of the formation of a black hole in a failed supernova would represent one of the most exciting results by HST both scientifically and for the public.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14267

Proposal Category: GO  
Scientific Category: Solar System  
ID: 14267  
Program Title: The Grand Finale : probing the origin of Saturn s aurorae with HST observations simultaneous to Cassini polar measurements  
  
Principal Investigator: Laurent Lamy  
  
PI Institution: Observatoire de Paris - Section de Meudon

With the increasing tilting of Saturn s north pole toward the Earth, HST has the opportunity to achieve unprecedented views of the entire northern aurorae at high spatial and temporal resolution. Such observations will shed light onto the auroral processes specific to the northern magnetosphere (the planet s magnetic dipole is offset toward the north) and compared to past similar observations of the southern aurorae. Furthermore, the Cassini spacecraft is about to start its last mission phase - the grand finale - with polar orbits around the planet, sampling the unexplored auroral regions at low altitude, before ultimately impacting the atmosphere. This proposal aims at taking advantage of this unique occasion to identify the acceleration processes responsible for Saturn's aurorae with HST remote observations combined with Cassini local measurements. HST images and spectra of the northern aurorae will primarily be scheduled when Cassini samples in situ the plasma conditions within the auroral regions, to assess fundamental plasma physics processes including acceleration, wave-particle interaction and energy/momentum transfer. Several HST orbits will also be coordinated with Cassini remote imaging of the southern aurorae to achieve a simultaneous view of both hemispheres and investigate magnetic (non-)conjugacy.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14268

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14268  
Program Title: Project AMIGA: Mapping the Circumgalactic Medium of Andromeda

Principal Investigator: Nicolas Lehner

PI Institution: University of Notre Dame

HST has transformed our view of galaxies by demonstrating that the diffuse circumgalactic medium (CGM) surrounding galaxies contains at least as many metals and baryons as their disks. UV absorption-line studies of single sight lines through an ensemble of galaxy halos have provided key new constraints to sophisticated cosmological simulations, in particular on the nature of feedback and accretion that drive CGM properties. Although largely unconstrained by studies limited to one sightline per galaxy, the geometry of the CGM has significant diagnostic power for critically testing simulation assumptions. We therefore propose Project AMIGA (Absorption Maps In the Gas of Andromeda) to map the CGM of the  $L^*$  galaxy M31 using COS G130M/G160M observations of 25 (18 new + 7 archival) sightlines at  $R=25$  to 330 kpc from M31 ( $0.08 < R/R_{\text{vir}} < 1.1$ ). We will determine the metal distribution of the cool and warm diffuse CGM gas separately and the total metal and baryonic masses of the M31 CGM. This survey will for the first time characterize the radial profile of a galaxy's CGM in three azimuthal zones (major+minor projected axes and an intermediate zone). Our team will use the spatial distribution of the CGM properties to test at an unprecedented level new numerical simulations, especially the physics of feedback. These observations and simulations will allow us to relate the observed CGM properties to the star formation history of M31. This Large program will make M31 a fundamental benchmark for studies of large-scale gas flows around galaxies, much as programs like PHAT have established it as a template for our understanding of stellar populations.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14269

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14269  
Program Title: Just the BASICs: Linking Gas Flows in the Circumgalactic Medium to Galaxies

Principal Investigator: Nicolas Lehner

PI Institution: University of Notre Dame

With HST/COS, we have discovered the cool, dense circumgalactic medium (CGM) of galaxies exhibits a bimodal metallicity distribution with well-separated branches peaking at 3% and 40% solar. The metal-rich peak may probe winds, recycled outflows, and tidally-stripped gas, while the metal-poor branch may trace cold accretion streams - a major source of fresh gas for star forming galaxies. We have also demonstrated strong CGM MgII absorbers are found preferentially along galaxies' poles, as expected if they arise in outflowing winds. These two results both give us fundamental insight into the manner in which galaxies exchange gas with the CGM, but the metallicity and geometry properties have never been jointly applied. We propose the Bimodal Absorption System Imaging Campaign (BASIC) to image 14 QSO fields with ACS. Combined with 9 archival HST fields, we will measure the geometry and morphology of 28 galaxies with well-characterized CGM absorbers. We will test if the bimodal metallicity distribution is connected to the geometric orientation of galaxies as predicted by simulations, assess the contribution of tidal-debris to CGM absorption, and measure the relationship of galaxy geometry and morphology to a broad range of cold/warm CGM tracers (especially OVI). Our sample is unique in that the metallicity of the CGM absorbers is well determined; it is the only sample for which this experiment can be done. The sight lines imaged by BASIC also represent an unique set of QSOs, many at  $z \sim 1$  and having the best S/N COS spectra available. BASIC will therefore enable science beyond its immediate goals, e.g., connecting the Ly $\alpha$  forest and metal-line absorbers with galaxies at  $z < 1$ .

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14270

Proposal Category: GO  
Scientific Category: Hot Stars  
ID: 14270  
Program Title: The late time behaviour and environments of the first gravitational wave transients

Principal Investigator: Andrew Levan

PI Institution: The University of Warwick

The next generation of gravitational wave (GW) detectors (Advanced LIGO and VIRGO) will go into scientific operation at the end of 2015. These detectors will finally herald an era where routine detection of gravitational waves from the merger of compact object binaries at 100-400 Mpc is possible, ending the century long quest for their direct detection. However, GW alone provides only part of the picture, and comprehensive electromagnetic observations will also be undertaken. Here we propose to utilize the unique ability of HST to go deep and with extremely high resolution in order to track the late time evolution of the counterparts, and characterise their environments in detail. These observations will in turn enable us to reconstruct the parameters of the explosions, pinpoint the birth sites, and hone our observations for future, more ambitious programmes of observations.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14271

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14271  
Program Title: Mapping the Radiative and Kinetic History of Fading AGNs

Principal Investigator: Walter Maksym

PI Institution: University of Alabama

We propose spectroscopic observations of extended emission line regions (EELRs) surrounding AGNs which appear to have faded by orders of magnitude over relatively short timescales (<100,000 years), transitioning from a bright QSO-like phase to a radiatively weak AGN phase. Recent HST images of galaxies selected by the Galaxy Zoo reveal complicated subarcsecond structures which can only be resolved with HST, including loops, filaments and misaligned ionization cones which provide important diagnostics the radiative history of these AGNs and their impact on the surrounding galactic medium.

With spatially resolved spectroscopy of the extended EELRs in these objects, we intend to probe QSO shutdown and AGN feedback on timescales shorter than possible through any other method. The emission line structure on spatial scales accessible only to HST provides evidence for recent transition from a radiative state to a kinematic, radio-dominated mode on timescales far shorter than would be expected from simple scaling of stellar-mass X-ray binaries (Done & Gierlinski, 2005). HST spectroscopy of this sample is therefore necessary, as it effectively provides the only known way to study the small-scale narrow-line features revealed by our HST imaging program.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14272

Proposal Category: GO  
Scientific Category: AGN/Quasars  
ID: 14272  
Program Title: Long-Term Ultraviolet Spectroscopy of a Tidal Disruption Event at only 90 Mpc

Principal Investigator: Walter Maksym

PI Institution: University of Alabama

We propose multi-epoch ultraviolet spectroscopy of ASASSN-14li, a stellar tidal disruption event (TDE) at ~90 Mpc. Such very nearby stellar TDEs have been thus far only observed about once per decade and provides an exceptional opportunity to study broad emission lines which describe the abundances and accretion flow of the stellar debris in one of the most important physical regimes for understanding basic TDE behavior. We also request brief XMM observations to constrain the high-energy spectral evolution on similar timescales. These observations will build upon surprising new results, and will provide an important foundation for follow-up of more ambiguous TDE candidates subsequently identified by LSST and WFIRST at higher redshifts.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14273

Proposal Category: GO  
Scientific Category: Debris Disks  
ID: 14273  
Program Title: A highly dynamical debris disc in an evolved planetary system

Principal Investigator: Christopher Manser

PI Institution: The University of Warwick

Our HST/COS survey for the photospheric pollution by planetary debris undisputably demonstrates that at least 25% of white dwarfs host an evolved planetary system. The debris discs holding the material that accretes onto the white dwarf are produced by the tidal disruption of asteroids, and are observed in nearly 40 systems by infrared excess emission from micron-sized dust. In a small number of cases, we have also detected double-peaked Ca II 860 nm emission lines from a metal-rich gaseous disc in addition to photospheric pollution and circumstellar dust. Our ground-based monitoring of the brightest of these systems, SDSS J1228+1040, over the last eleven years shows a dramatic morphological change in the emission line profiles on the time-scale of years. The evolution of the line profiles is consistent with the precession of an eccentric disc on a period of ~25 years, indicating a recent dynamical interaction within the underlying dust disc. This could either be related to the initial circularisation of the disc, or a secondary impact onto an existing disc. We expect that the accretion rate onto the white dwarf varies on the same timescale as the Ca II emission lines, and there is the tantalising possibility to detect changes in the bulk abundances, if the impact of a planetesimal with a different bulk abundance stirred up the disc. We request a small amount of COS time to monitor the debris abundances over the next three HST Cycles to test this hypothesis, and bolster our understanding of the late evolution of planetary systems.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14274

Proposal Category: GO  
Scientific Category: ISM and Circumstellar Matter  
ID: 14274  
Program Title: Spectral Time Series of the Cas A Supernova

Principal Investigator: Armin Rest

PI Institution: Space Telescope Science Institute

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

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

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14275

Proposal Category: GO  
Scientific Category: Cosmology  
ID: 14275  
Program Title: Tracing the CMB Cold Spot supervoid using HI gas clouds

Principal Investigator: Tom Shanks

PI Institution: Durham University

The Cosmic Microwave Background (CMB) Cold Spot, a  $\sim 100$  sq. deg. area with abnormally low temperatures, remains one of the greatest anomalies of the cosmic microwave sky. If primordial in origin, it represents a 3-4 sigma fluctuation in a LCDM cosmology. The alternative possibility is that it is caused by the Integrated Sachs-Wolfe (ISW) effect where a foreground supervoid imparts a net gravitational redshift to the CMB photons as they pass through. Recently such a supervoid has been claimed to be detected in the galaxy distribution at  $z \sim 0.2$ , with a  $\sim 300/h$  Mpc diameter, representing a 2 sigma fluctuation in the LCDM model. Our prime aim is to test if the void is independently detected in the intergalactic medium traced by HI Lyman alpha absorption. Two quasar sightlines at  $\sim 10$ deg from the Cold Spot centre have already been serendipitously observed by COS and these show a tentative ( $\sim 3$  sigma) deficiency of Lyman-alpha absorption lines (Mackenzie et al 2015). In order to test further this potentially exciting detection of the Cold Spot supervoid in absorption we propose to use COS to observe 4 more quasars within a few degrees of the Cold Spot centre. If the HI underdensity reproduces at the same level then this could provide a  $>4$  sigma detection of the supervoid. Such a result would not only be vital for a cosmological explanation of the Cold Spot anomaly but also revolutionise our view of how hydrogen gas clouds trace dark matter underdensities on the largest scales.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14276

Proposal Category: GO  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14276  
Program Title: Understanding the star formation environment of a very low redshift, low luminosity, long Gamma Ray Burst

Principal Investigator: Elizabeth Stanway

PI Institution: The University of Warwick

Gamma ray bursts (GRBs) are potentially observable to the highest redshift, but their interpretation relies on a knowledge of their hosts and environment. GRB hosts are identified by a single stellar explosion which allows strong statistical statements on the global star formation distribution. However making these relies on local, low redshift exemplars in which the conditions giving rise to bursts can be studied. Unfortunately such sources are rare.

We have identified an unusual, dusty GRB host in the local universe (host of low-luminosity GRB 080517 at  $z=0.09$ ) which shows strong star formation and is exceptionally luminous in the infrared. It is also within 25 kpc and a few hundred km/s of a neighbouring galaxy, itself undergoing a merger. In this programme we wish to map this system in the ultraviolet and infrared. We will evaluate evidence for clumpy star formation and tidal interactions between the two galaxies, determining whether galaxy interactions may have contributed to the starbursts in both galaxies, and assessing whether this may have played a role in triggering the burst. If so, it is likely that the role of clustering and larger scale environment needs to be reassessed in inferences drawn from the redshift distribution of GRBs.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14277

Proposal Category: GO  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14277  
Program Title: Probing Hot Gas in Spiral-Rich Galaxy Groups

Principal Investigator: John Stocke

PI Institution: University of Colorado at Boulder

Approximately 30% of the baryons in spiral galaxies like the Milky Way are "missing" in the sense that while predicted to be present by numerical simulations and chemical evolution histories, this gas has not been detected as yet. Based on recent high-S/N ( $> 20$ ) COS far-UV spectroscopy, this gas MAY have been detected as broad, shallow Ly alpha and OVI absorptions associated with foreground spiral-rich galaxy groups. These low-contrast features associated with  $T > 10^5$  K gas have not been detected by any other COS program probing galaxy, group or cluster halos due to insufficient S/N.

This proposal seeks to confirm or deny the presence of massive reservoirs of spiral group gas by obtaining high-S/N ( $> 20$ ) GOS G130M spectra of 10 bright QSOs behind 12 (two sightlines probe two groups each) low-z (0.1-0.2) galaxy groups selected from the SDSS using a consistent group-finding algorithm. Selecting the groups first, then searching for the absorptions provides a homogeneously-selected group sample to investigate and allows us to choose sightlines which probe these groups at a range of radii from their centers (0.3-1.4  $R_{\text{virial}}$ ) and which do not pass close to individual group galaxies. The redshift selection places the OVI doublet and Ly alpha in regions of highest COS sensitivity. The UV-initiative program to detect these subtle absorption features requires a total of 45 orbits to execute.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14278

Proposal Category: AR  
Scientific Category: Extra-Solar Planets  
ID: 14278  
Program Title: Scanning Red Skies: Contribution Functions for Interpreting HST Multi-Layer Observations of Ultracool Atmospheres  
Principal Investigator: Daniel Apai  
PI Institution: University of Arizona

The physics of condensate clouds pose one of the greatest challenges to our understanding of brown dwarfs, transiting hot jupiters, and directly imaged exoplanets.

The combination of HST's unique sensitivity and photometric precision enables powerful time-resolved observations of rotating ultracool atmospheres and in 9 recent programs using 128 orbits 44 brown dwarfs and exoplanets have been observed in full or partial rotations. These data are leading to breakthroughs in our understanding of condensate clouds.

The broad wavelength coverage of HST/WFC3 provides a particularly powerful probe of the atmospheres as different wavelengths probe different layers in the atmospheres, typically between 0.1 mbar and 20 bar. Therefore, rotational phase mapping observations at multiple layers can be translated to multi-layer maps, i.e., longitudinal-vertical maps of the atmospheres. Such maps are key to testing and developing a general cloud model valid for ultracool atmospheres. However, no database or model grid is currently available to easily translate the collected light curves into pressure levels or to plan observations of specific pressure levels.

We propose here to calculate contribution functions (emerging flux as a function of pressure and wavelength) for a uniquely large grid of model atmospheres. The contribution functions will provide a direct, easily applicable tool to: 1) translate existing and future rotational phase maps of ultracool atmospheres to longitudinal-vertical cloud maps; 2) plan the optimal observing strategy for future HST and JWST observations. We will also apply the tool to published HST observations to link variability amplitude to pressure levels.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14279

Proposal Category: AR  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14279  
Program Title: A model-independent assessment of the effects of dust attenuation at  $0.5 < z < 1$  on HST-derived F814W galaxy morphologies, structures and luminosities  
Principal Investigator: Eric Bell  
PI Institution: University of Michigan

HST has invested thousands of orbits in carefully measuring intermediate-redshift galaxy structures and morphologies (structures hereafter), photometric redshifts and stellar populations, forming the bedrock of our measurements of galaxy evolution. Yet, studies of nearby galaxies show that the structures of galaxies and their spectral energy distributions (SEDs) are strongly affected by dust. Given that the  $0.5 < z < 1$  galaxy population appears more gas and dust rich than the local population, a model-independent measurement of the effects of dust on galaxy structures and SEDs is urgently needed.

We propose to use long-wavelength Spitzer IRAC and MIPS data for the HST-COSMOS survey to select samples of star-forming dusty disk galaxies with  $0.5 < z < 1$  and  $M^* > 1e10 M_{\text{sun}}$  in a way that depends neither on dust attenuation nor on galaxy inclination. This selection yields a sample of very similar disk galaxies, viewed from random viewing angles; COSMOS is the ideal dataset owing to its large size, its superb depth, and its widely-used public catalogs of galaxy structures. Following the methods we have developed using the SDSS, we will measure changes in F814W-derived galaxy structure with axis ratio (inclination), measuring for the first time ever the differential effects of dust attenuation on galaxy structures at  $0.5 < z < 1$ . We will measure the change in SEDs with axis ratio, providing a model-independent measure of the difference in attenuation between face-on and edge-on as a function of galaxy parameters. Finally, we will critically assess individual galaxy attenuation measures from stellar population model plus dust fits, providing a crucial test of these widely used methods.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14280

Proposal Category: AR  
Scientific Category: Cosmology  
ID: 14280  
Program Title: Breaking Cosmic Dawn: Observing the  $z \sim 7$  Universe Through Cosmic Telescopes

Principal Investigator: Marusa Bradac

PI Institution: University of California - Davis

Cluster-scale gravitational lenses act as cosmic telescopes, enabling the study of otherwise unobservable galaxies. To use these cosmic telescopes we need robustly derived magnification maps and error analyses. They are essential to understand the systematic errors present in such investigations. While the STScI special call for proposals to get magnification information for Hubble Frontier Fields (HFF) provided the first-order maps, this proposal will add (i) ultra deep HFF data, (ii) HST and Keck spectroscopy, (iii) improved weak lensing treatment, and (iv) flexion analysis to produce a factor of 2 improvement in precision of the magnification estimates for the HFF clusters.

The improved magnification models developed here will result in a significant improvement of our knowledge about the  $z \sim 7$  Universe. In particular, reaching fainter luminosities to higher precision and adding Spitzer data, with this proposal we will study the role that these galaxies play in galaxy formation models (by accurately measuring stellar masses, ages and star formation rates) and their contribution to the bulk of ionizing photons necessary to drive reionization. These tasks are made possible by the power of cosmic telescopes, the vast amounts of HST, Spitzer, and ground based data acquired in these fields, and our previously demonstrated techniques for accurately quantifying magnification of cosmic telescopes and stellar properties of  $z \sim 7$  galaxies. All the lens models as well as Spitzer imaging and photometry will be made available to the community, making this proposal of lasting legacy value.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14281

Proposal Category: AR  
Scientific Category: Resolved Stellar Populations  
ID: 14281  
Program Title: Small Statistics No More: a suite of simulated dwarf galaxies to interpret observations  
  
Principal Investigator: Alyson Brooks  
  
PI Institution: Rutgers the State University of New Jersey

Thousands of HST orbits have been dedicated to obtaining resolved images of individual stars in local galaxies, in order to create color-magnitude diagrams that can discern their star formation histories. Most of these galaxies are dwarfs, thought to be the primary drivers of reionization, and ideal testbeds for understanding the nature of dark matter and the impact of energetic feedback on star formation. Meanwhile, simulators have recently achieved success in reproducing these dwarf galaxies for the first time. We propose here to expand a successful model for dwarf galaxies to the largest simulation sample ever run, simulating  $\sim 100$  dwarfs with stellar masses  $< 10^9 M_{\text{sun}}$ . We will achieve this by running large zoomed-in regions that contain many dwarfs. These regions will sample a range of under- and over-densities with respect to the cosmic mean, and thus the dwarfs will span a range of stellar and halo masses, and merger and accretion histories. Importantly, we will mimic the observations, creating mock color-magnitude diagrams so that distinguishing features related to evolution can be identified. With this sample, we will tie star formation histories to kinematics, dark matter structure, and gas fractions. We will make predictions for age and metallicity gradients. Finally, we will generate mock images of the dwarfs near the epoch of reionization, testing the escape fraction of ionizing radiation and duty cycle, and making predictions for detectability with JWST.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14282

Proposal Category: AR  
Scientific Category: Unresolved Star Formation  
ID: 14282  
Program Title: Simulating Ultra-faint Dwarf Galaxies: The Hallmark of Reionization at the Threshold of Galaxy Formation  
  
Principal Investigator: James Bullock  
  
PI Institution: University of California - Irvine

Ultra-faint dwarf galaxies (UFDs) include the faintest, lowest-metallicity, and most dark-matter dominated galaxies known, providing unique and particularly powerful laboratories for our understanding of galaxy formation at the earliest times and in the lowest mass dark matter halos that host long-lived stars. Among the most striking discoveries about UFDs is that they appear to contain exclusively ancient stars ( $> 10$  Gyr), an insight made possible by extremely deep HST imaging. Remarkably, this is exactly the age distribution expected in a scenario where the Missing Satellites Problem is primarily solved via early reionization-related feedback.

Motivated by these exciting results from HST, this proposal is aimed at understanding the cosmological formation of UFDs using ultra-high resolution cosmological simulations. We aim to determine the relationship between the global reionization history and the observed star formation histories of low-mass dwarfs. We will also determine the relationship between halo mass and stellar mass at the dwarf regime, and use these results to inform our interpretation of dwarf galaxy counts in the Local Group in the context of  $\Lambda$ CDM cosmology. Our simulations, based on the FIRE star formation scheme, will carefully track the impact of local stellar feedback and global reionization feedback on the star formation histories of dwarf galaxies. Using zoom-in simulations over a range of dwarf-sized halos, we will explore the physical origin of the transition between uniformly (and anciently) quenched UFDs to the slightly larger "classical" dwarfs that appear to be star-forming at  $z=0$  in the absence of environmental quenching.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14283

Proposal Category: AR  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14283  
Program Title: Detangling Galaxy Spectra: A Baseline Calibration Using Resolved Stars

Principal Investigator: Nell Byler

PI Institution: University of Washington

Translating observed flux from galaxies into meaningful astrophysical quantities relies on "stellar population synthesis" (SPS) models. These models are broadly applied throughout extragalactic astronomy, at both high and low redshifts and to both photometric and spectroscopic spectral energy distributions (SEDs). Despite their widespread use, SPS models suffer from systematic biases that stem from incomplete input physics and are unreliable when used to derive physical parameters, due to inherent degeneracies in interpreting the SED. Unfortunately, it is difficult to predict how these limitations propagate into uncertainties in galaxy properties, or how the models perform when used on sub-kiloparsec scales.

Uncertainties in SPS models are becoming the limiting factor in our interpretation of galaxy spectra, but remarkably, there is no existing ground truth data against which to test these models, aside from stellar clusters. This proposal is the first step in remedying this situation. We propose to use resolved stellar population observations from HST to constrain the stellar masses, ages, and star formation histories in regions matched to 2D spectroscopic observations from MaNGA. By sampling many subregions of a single galaxy, we will generate a publicly-released library of galaxy spectra matched to the true underlying stellar populations. This library will provide an initial "gold standard" comparison set that can be used to assess the accuracy of any SPS model.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14284

Proposal Category: AR  
Scientific Category: Cosmology  
ID: 14284  
Program Title: Measuring the Subhalo Mass Function with Flexion

Principal Investigator: Benjamin Cain

PI Institution: University of California - Davis

Mass substructure is a key test of the standard cosmology, and galaxy clusters are an ideal laboratory for measuring substructure with gravitational lensing. By including flexion, a higher-order image distortion, along with strong and weak lensing in our mass reconstructions, we can measure substructure with masses as small as  $10^{12} M_{\text{sun}}$ . To increase the legacy value of the rich set of HST cluster data images, we propose to add a flexion mass measurement and improved mass reconstruction for 26 clusters. With this sample and our substructure mass detection threshold, we will constrain the subhalo mass function to 10% and constrain a deviation from halo self-similarity predicted in N-body simulations. This is an important test of our understanding of structure formation in the Universe.

In addition to the mass modeling, we propose an analysis of intrinsic flexion - scatter in the shape measurements due to intrinsic galaxy morphology, as well as PSF systematics and source selection biases, using the parallel fields of the cluster observations as our data set. This will be the most in-depth study of flexion systematics to date, particularly considering that we will be using real galaxy images instead of simulated data, and critical to validating the mass maps produced using flexion. We will release the mass maps and associated lensing maps to the community, increasing the value of the data.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14285

Proposal Category: AR  
Scientific Category: Unresolved Star Formation  
ID: 14285  
Program Title: The Young Star Groups in Dwarf Galaxies

Principal Investigator: Daniela Calzetti

PI Institution: University of Massachusetts - Amherst

Dwarf galaxies are the building blocks of all galaxies observed today, but star formation is still an ill-understood process in these unevolved systems. This archival project aims at obtaining a comprehensive census of all young (<100 Myr) clusters and associations in a complete sample of dwarfs within the local ~3.5 Mpc. ACS and/or WFPC2 images in V and I exist for all the galaxies, and these will be supplemented by ground based UBR and H-alpha images, most already available, to obtain full spectral energy distributions (SEDs) for all sources at UBRHa. Bayesian routines that implement stochastic sampling of the stellar Initial Mass Function will be used to obtain physical parameters (age, mass, extinction) for the sources from their SEDs. Our novel approach for the identification of clustered structures indicates a ten-fold improvement in the statistics of clusters/associations over existing literature. We will use the data to investigate (1) whether the dearth of ionizing photons in dwarfs is an effect of deficiency in the production of massive stars, and (2) provide robust estimates for the cluster formation efficiencies in these low star formation rate systems. Our study, and the resulting catalogs of clusters and associations, will maximally leverage the HST archival holdings in order to place dwarfs more securely within the broader perspective of galaxies as a whole, and will provide a unique resource for the broader community.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14286

Proposal Category: AR  
Scientific Category: AGN/Quasars  
ID: 14286  
Program Title: Deciphering the Fossil Record in Quasar Ionization Echoes

Principal Investigator: Marios Chatzikos

PI Institution: University of Kentucky

Objects like Hanny's Voorwerp contain information about the light output of currently weak AGN as it stood 10,000 to 100,000 years ago. They consist of clouds at the outskirts of galaxies, and they are particularly bright in [O III] 5007Å. Their value lies in the fact that they provide information on the history of AGN luminosity over timescales that are otherwise inaccessible. Many similar objects have been discovered recently, and their numbers are expected to grow with deep observations at higher redshift, such as those JWST will permit. A tool to faithfully interpret the quasar fossil record is needed.

We request funding to bolster our theoretical understanding of quasar ionization echoes. The proposed work will unfold in two parts. In the first part, we will develop infrastructure in the spectral synthesis code Cloudy to model the evolution of optically thin clouds exposed to fading radiation fields. In the second part, we will use this infrastructure to produce diagnostics that can put tight constraints on the cloud age, as well as on the initial AGN luminosity.

Cloudy is already being used for the purposes of understanding Voorwerpjes, albeit with static models that do not capture the intricacies of evolving systems. Our work will have an immediate impact on the interpretation of HST observations of these objects, and it will pave the way for future JWST programs.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14287

Proposal Category: AR  
Scientific Category: AGN/Quasars  
ID: 14287  
Program Title: Triggering and Quenching: simulations and mock observations of Active Galactic Nuclei and their hosts  
Principal Investigator: Ena Choi  
PI Institution: Rutgers the State University of New Jersey

The lives of galaxies and their supermassive black holes (SMBH) are probably intimately linked. Deep multi-wavelength surveys with HST are now providing detailed imaging of a statistically robust sample of obscured and unobscured AGN hosts, along with control samples of inactive galaxies, giving us an unprecedented opportunity to study the relationship between AGN and their hosts. However, so far these observations have uncovered more puzzles than they have resolved. Although mergers are considered a promising triggering mechanism for AGN activity, numerous studies have shown that AGN hosts are no more likely to appear morphologically disturbed than inactive galaxies. Studies of whether AGN hosts exhibit enhanced or suppressed star formation have also yielded conflicting results. We propose to run a suite of state-of-the-art simulations to study the AGN-host galaxy connection. These simulations will be post-processed with a radiative transfer code, a sub-grid model for torus-scale obscuration, and short timescale AGN variability. Using mock images created from the simulations, we will study the predicted morphologies and stellar populations of AGN hosts and "normal" galaxies with similar stellar masses. We will use our simulations to address two major science questions: (1) how is SMBH growth fueled and fed, and what triggers rapid feeding, and (2) how does AGN feedback regulate BH growth and the growth of the host galaxy? In addition, we will release our simulation outputs and mock images and catalogs to the community through MAST.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14288

Proposal Category: AR  
Scientific Category: Unresolved Star Formation  
ID: 14288  
Program Title: A New Method to Measure the UV Escape Fraction from Galaxies

Principal Investigator: Yumi Choi

PI Institution: University of Washington

For cosmic reionization to be complete by a redshift of  $\sim 6$ , the escape fraction of ionizing photons from starburst dwarf galaxies in the early universe is expected to be higher than  $\sim 20\%$ . However, measurements of the escape fraction from analogous galaxies are poorly constrained, and suggest dramatically lower escape fractions than expected, in the few cases where the escaping photons can be detected at all. These measurements are largely inconclusive because they are forced to rely on a number of coarse assumptions that can strongly bias results to low escape fractions.

We propose to remedy this situation by developing an entirely new methodology that (1) uses spectral energy distribution fitting of resolved stars to infer both the production of ionizing photons and their absorption by dust and (2) uses narrow band images of Balmer lines to track the absorption of ionizing photons by neutral gas. These measurements allow us to derive maps of the ionizing escape fraction across the face of a galaxy, while avoiding assumptions about dust geometry and systematic errors inherent in using spatially-averaged spectra to infer the ionizing photon production rate. We will develop and test the needed machinery in the nearby starburst galaxy NGC 4214. Using this galaxy as a test case, we can shed light on limitations in traditional methodologies by comparing to the results from our new method. Once developed, this simpler methodology can easily be applied to a much larger sample of nearby galaxies, allowing a broad attack on understanding this important but elusive process.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14289

Proposal Category: AR  
Scientific Category: Cosmology  
ID: 14289  
Program Title: The Faint Galaxy Frontier: Galaxy Formation at the Extremes of Mass and Density in the Deep Fields  
  
Principal Investigator: Michael Cooper  
  
PI Institution: University of California - Irvine

The formation and abundance of the lowest luminosity galaxies represents one of the most significant issues facing galaxy formation today. The faintest galaxies probe feedback at its most effective and may offer clues to the particle nature of dark matter itself. Currently, we are secure in our accounting of the faint  $\sim 10^{6.5}$  Msun dwarfs only in the Local Group -- a regime that has gotten much attention via its association with the "Missing Satellites" and "Too Big to Fail" problems. However, the Local Group is just one system with limited statistical power -- it may not be typical of the Universe at large. We propose to mine the deepest HST pointings, including the new Frontier Fields, so as to measure the stellar mass function to unparalleled depths in three distinct environments: cluster cores, cluster outskirts, and the field. Through comparison to corresponding high-resolution cosmological simulations, we will test LCDM-based galaxy formation at unprecedented scales and over the widest possible environmental range.

Only HST provides the photometric depth and precision needed to study galaxies at this critical low-mass regime ( $< 10^8$  Msun). Yet, while extremely deep HST imaging has existed in the field, the Frontier Fields supply the missing ingredient, by allowing us to probe the high-density regime in comparable detail. In addition to addressing the failures of galaxy formation models, our proposed program will produce a variety of observational data products (e.g. stellar mass, photo-z, and environment catalogs) as well as high-resolution simulations that will be of significant value to the community in conducting complementary analyses in the HST Deep Fields.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14290

Proposal Category: AR  
Scientific Category: AGN/Quasars  
ID: 14290  
Program Title: What is the Impact of Narrow-Line Region Outflows on AGN Feedback?

Principal Investigator: D. Crenshaw

PI Institution: Georgia State University Research Foundation

Mass outflows of ionized gas are often detected in the narrow-line regions (NLRs) of nearby AGN. These outflows are potentially very important for the growth and coevolution of supermassive black holes (SMBHs) and their host galaxy bulges, because they may provide significant feedback on the scales of nuclear star formation and bulge growth (hundreds of parsecs). To investigate this issue, we conducted a pilot study of the NLR in the Seyfert 1 galaxy NGC 4151 using existing HST observations, and were able to determine the mass outflow rate and kinetic luminosity as a function of position in the NLR of an AGN for the first time. We found that NLR outflows can indeed provide effective feedback in this AGN on scales where circumnuclear star formation and bulge growth occur. How general is this result, what are the ranges in feedback parameters in AGN, and what is their dependence on luminosity? We will address these questions with an HST archive study of 9 additional Seyfert galaxies, using STIS low-dispersion spectra, WFPC2 or WFC3 [O III] images, kinematic models, and photoionization models to determine mass outflow rates and kinetic luminosities as a function of position in their NLRs. These parameters will allow us to gauge the overall importance of NLR outflows as feedback mechanisms in moderate luminosity AGN, and provide a framework for understanding the mechanisms of feedback in other types of AGN, including more luminous quasars at higher redshifts.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14291

Proposal Category: AR  
Scientific Category: Cosmology  
ID: 14291  
Program Title: Backsplash as a probe of cosmology

Principal Investigator: Neal Dalal

PI Institution: University of Illinois at Urbana - Champaign

We propose to investigate a newly discovered feature in the density profiles of dark matter halos found in numerical simulations. This feature, a localized steepening of the density profile associated with backplash material, could provide a calibratable standard ruler enabling new probes of the background cosmology. The proposed theoretical work would directly benefit HST observing programs that measure weak gravitational lensing of galaxy clusters, by providing a new cosmological test that cluster observations could perform, possibly using existing data.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14292

Proposal Category: AR  
Scientific Category: ISM and Circumstellar Matter  
ID: 14292  
Program Title: Investigating the Gas within the Planck Galactic Cold Clumps

Principal Investigator: Cody Dirks

PI Institution: Northwestern University

The recent release of the Planck Catalogue of Galactic Cold Clumps (PGCC) has provided a wealth of information about the cold dust content of the ISM across the entire sky. The purpose of the PGCC is to eventually yield insight into the processes by which interstellar material progresses from the diffuse ISM to molecular clouds to stars. By combining the data from Planck with the diagnostic capabilities of UV absorption line spectroscopy, we aim to better characterize the physical conditions of the interstellar gas within these cold clouds. To our knowledge, there have been no studies using HST to investigate the properties of the gas within the cold dust clouds discovered by Planck. We have identified 35 sightlines containing 165 datasets within the HST STIS archive that fall near one or more of these PGCC clouds. We propose to analyze the corresponding interstellar absorption lines contained within these datasets to study a variety of important cloud properties. Our goals in this archival study are to investigate the gas thermal pressure using C I fine-structure excitation, and look for evidence of shock processing in the dust by determining the abundance ratio between depleted and undepleted elements. Additionally, we plan to measure the isotopic abundance ratio of CO in the clouds and investigate if high pressures are affecting their chemical processes.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14293

Proposal Category: AR  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14293  
Program Title: Metallicity and Azimuthal Angle Diagnostics of Inflows and Outflows: Interpreting HST Measurements of Circum-Galactic Gas Flows  
Principal Investigator: Claude-Andre Faucher-Giguere  
PI Institution: Northwestern University/CIERA

Galaxies do not grow in sync with their dark matter halos, the stellar masses of galaxies being typically more than one order of magnitude below the cosmic baryon fraction. The regulation of galaxy growth occurs in the circum-galactic medium (CGM), where gas accretion from the cosmic web and galactic outflows interact with one another. Major progress in probing inflows and outflows observationally has been enabled by HST/COS, which has uncovered evidence for a bi-modality in the metallicity distribution of Lyman limit systems (LLSs) associated with CGM gas. The low- and high-metallicity branches have tentatively been identified with inflows and outflows, respectively, but this interpretation remains uncertain because no published simulation has reproduced the observed bi-modality. Complementary measurements using HST imaging have revealed a bi-modality in the azimuthal angle distribution of strong Mg II absorbers relative to the disk of star-forming galaxies. The azimuthal angle bi-modality has also tentatively been interpreted as a way to separate inflows and outflows. We will use a new suite of ultra-high resolution cosmological simulations with resolved ISM physics and stellar feedback, combined with radiative transfer, to study the physical nature of CGM absorbers. By tracking the history of gas elements in our simulations, we will quantify the association of absorbers of different metallicity and azimuthal angle with inflows, outflows, and stripping processes, and develop long-sought diagnostics of inflows and outflows. We will directly compare mock absorption spectra from our simulations to COS data and make several key predictions testable over the next few years.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14294

Proposal Category: AR  
Scientific Category: Solar System  
ID: 14294  
Program Title: Characterizing Outbursts and Nucleus Properties of Comet 29P/Schwassmann-Wachmann 1  
Principal Investigator: Yanga Fernandez  
PI Institution: University of Central Florida

Today's comets are remnant bodies leftover from the era of planet formation in our own Solar System. Therefore characterizing cometary structure and composition can give clues to the thermal, physical, and chemical environment of the protoplanetary disk. However before this long-term 'holy grail' of planetary astronomy can be achieved, we must understand cometary evolution so that we can know how comets have changed since their formation. The phenomenon of cometary activity, where a porous matrix of icy and rocky material turns into the gases and the dust grains we see in a comet's coma, remains a poorly-understood puzzle of short-term cometary evolution. We are in the midst of an ongoing project to understand cometary activity in a particular comet, 29P/Schwassmann-Wachmann 1, by taking advantage of existing imaging datasets that show the comet in outburst. Outbursts are useful for constraining the nucleus's spin state and the location of active areas. We propose here to analyze archival WFPC2 images of comet 29P obtained in March 1996 (Cycle 5, Project 5829), spanning 21 hours, that show the comet in outburst. These data are the highest-resolution imaging of this comet ever obtained while it was in outburst. We will analyze the morphology of the comet's dust coma to constrain properties of the nucleus and of the dust grains themselves. Additionally, we will analyze images taken in May 2000 (Cycle 8, Project 8274) that show the comet at its steady-state level of activity but may also allow us to place further constraints on the nucleus's active regions.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14295

Proposal Category: AR  
Scientific Category: Resolved Stellar Populations  
ID: 14295  
Program Title: The Local Environments of Supernovae from Archival HST Images

Principal Investigator: Alex Filippenko

PI Institution: University of California - Berkeley

The locations of supernovae (SNe) in the local stellar and gaseous environment in galaxies, as measured in high-resolution WFPC2, NICMOS, ACS, and WFC3 images, contain important clues to their progenitor stars. They provide accurate determinations of any association of SNe with HII regions or star clusters. Since multi-filter observations are generally available, we can assess the local stellar population, setting constraints on the mass of the progenitor; we can also search for possible attenuation of the SN by dust in the host galaxy by studying the colors of the stars in its environment. By checking the fields for background sources, we can correct the existing SN light curves and luminosities if necessary. When a SN has been observed incidentally, information can be gained on its optical and UV emission. Deep HST images can be used to find light echoes of SNe, as well as recover SNe interacting with circumstellar material at very late times. A direct search for the progenitor stars of SNe can be made in pre-existing HST images of their locations; as the number of archival HST images steadily increases, along with the number of newly discovered SNe, positive identifications become progressively more likely. In Cycle 23, we plan to extend our successful work from previous cycles. This proposal is complementary to our Cycle 23 snapshot proposal, whose primary purpose is to obtain late-time photometry of SNe. It is also complementary to our Cycle 23 ToO proposal, which is largely designed to pinpoint the locations of new SNe to help determine their progenitor stars.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14296

Proposal Category: AR  
Scientific Category: Hot Stars  
ID: 14296  
Program Title: Archival Investigations of the Local Environments of Supernovae

Principal Investigator: Ryan Foley

PI Institution: University of Illinois at Urbana - Champaign

Supernovae (SNe) and their galaxies are intimately linked. The stars that explode are formed from the gas in the galaxy, and when they explode, they enrich and energize that gas. Unsurprisingly, SNe from massive stars tend to be found in star-forming galaxies, while SNe Ia, with their longer lived progenitors, are found in all galaxies.

In addition to global properties, SN properties are strongly correlated with local galactic environments. For instance, stripped-envelope core-collapse SNe (those without massive hydrogen envelopes) tend to be found in the highest star-forming regions of their galaxies while other SNe are less particular. At low- $z$  where local environments are resolved from the ground, these connections provide unique perspectives on progenitors and explosion mechanisms. But these studies are limited. To measure any redshift evolution and to study the rarest events, we must look at high- $z$  SNe - and to measure their local environments, we need HST.

The Pan-STARRS (PS1) Medium-Deep Survey has discovered at least 162 transients which have, in total, over 1311 archival HST images of their local galactic environment. The PS1/HST sample contains roughly 100 SNe Ia, 50 core-collapse SNe (including several super-luminous SNe), and 10 other transients such as luminous blue variables, tidal disruption events, and novae. This is the largest such dataset in existence.

We propose to study the local environments of SNe by taking advantage of the pre-existing HST imaging of PS1 transients. We plan to use these data to investigate how local environments influence the rate, luminosity, and other physical characteristics of all varieties of SNe and other transients.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14297

Proposal Category: AR  
Scientific Category: ISM in External Galaxies  
ID: 14297  
Program Title: Gaseous infall and star formation from redshift 2 to the Milky Way

Principal Investigator: Alex Hill

PI Institution: Haverford College

We propose to model magnetized gas as it flows into galaxy disks in Milky Way-like and redshift  $\sim 2$  environments in order to understand the pc to kpc scale physics that control a crucial link in galaxy evolution: how do galaxies get the gas which sustains star formation over cosmic time? UV observations with the Cosmic Origins Spectrograph (COS) on HST have demonstrated that star-forming galaxies have baryonic halos much more massive than the galaxies themselves; these halos are most likely a link in the evolution of galaxies as cosmological filaments feed ongoing star formation in galactic disks. However, the galaxy formation simulations that support this hypothesis do not resolve the parsec-scale hydrodynamic processes which determine if and how the gas in the halo can reach the disk. To address this theoretical disconnect, we will conduct magnetohydrodynamic simulations in which these clouds fall under the galactic potential into a state-of-the-art simulation of the three-phase interstellar medium in the galactic disk. We will leverage recent HST and radio observations of accreting clouds around the Milky Way to set the initial conditions of the gas, including magnetic fields and metallicity. Our results will connect the HST metallicity measurements directly to the impact of gaseous galactic halos and infall on galaxy evolution and the star formation history of the Universe.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14298

Proposal Category: AR  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14298  
Program Title: What Drives Star Formation in Galaxies?: Combining the Strengths of HST and Herschel  
  
Principal Investigator: Jeyhan Kartaltepe  
  
PI Institution: National Optical Astronomy Observatory, AURA

We propose to conduct a large scale, comprehensive analysis of infrared galaxies observed by Herschel by combining all of the Herschel survey fields that have HST imaging data. These fields span a large range of area and depth (COSMOS, AEGIS, ECDFS and the CANDELS fields GOODS-N, GOODS-S, UDS, EGS, and a portion of COSMOS). We will conduct a detailed morphological analysis of the optical and near-infrared HST images for the expected 8000 sources over these fields in order to determine how galaxy morphology is related to a galaxy's star formation rate and specific star formation rate and how that relationship has changed over time. In particular, we will investigate the role that galaxy mergers and interactions have had in fueling star formation for galaxies on the main sequence as well as for starbursts with significantly elevated star formation rates. In addition to looking for merger signatures, we will explore other morphological properties. For example, how does the bulge to disk ratio evolve for these galaxies? Are starburst galaxies more likely to be compact systems? What are the properties of clumpy galaxies and are they evidence for disk instabilities at high redshift? For objects that are not detected in Herschel imaging, we will conduct a stacking analysis to measure the mean SFR for various populations, such as 24 micron galaxies, compact galaxies, and barred galaxies. We plan to make all of our images and catalogs, including our morphological and SFR measurements, available to the public and we expect this dataset to be of lasting legacy value to the community.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14299

Proposal Category: AR  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14299  
Program Title: A New Galactic Wind Model to Better Understand the Implications of QSO Absorption lines  
Principal Investigator: Neal Katz

PI Institution: University of Massachusetts - Amherst

QSO absorption line studies of the CGM using HST COS are the best direct way to study the accretion and galactic wind processes that are thought to dominate galaxy formation. Detailed numerical simulations are critical to interpret and understand these observations. Unfortunately, interactions at wind/halo gas interfaces in the CGM occur on scales that are much below the resolution of any current galaxy formation simulation. To mitigate this impasse, we propose to implement a new wind algorithm that explicitly models the "subgrid physics" in the wind-halo gas interaction analytically within a simulation, using the simulation to provide the physical characteristics that will inform the interaction. Unavoidably, this introduces a couple free parameters but we can restrict them by matching observed galaxy properties. We will conduct simulations to test and tune the new wind model to match the galaxy stellar and HI mass function. Then using the new wind model, we will perform a large-volume, high-resolution simulation that we will compare with COS observations similar to our group's previous comparisons, to better understand their implications for galaxy formation. Our existing simulations reproduce many observed properties of galaxies and metal-line absorption, but the new wind implementation will allow us to tie empirical successes, and failures, more securely to the underlying wind physics, both the ejection

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14300

Proposal Category: AR  
Scientific Category: Cosmology  
ID: 14300  
Program Title: Searching for faint high-z galaxies in the Hubble Frontier Fields

Principal Investigator: Rachael Livermore

PI Institution: University of Texas at Austin

We request funding to support the study of the complete data from the Hubble Frontier Fields (HFF) program. We have developed a method for detecting the faintest lensed galaxies in the cluster fields using wavelet decomposition, and propose to use these data to study several key science areas:

1) The faint end of the rest-frame ultraviolet (UV) luminosity function at  $z=7-8$ : We will improve the estimates of the faint-end slope, which remains poorly constrained. The lensing fields will probe luminosities  $\ll 0.1L^*$ , while the blank fields will increase the number of  $<0.5L^*$  galaxies by a factor of 3x. By the completion of the HFF survey, we expect to be able to measure the faint-end slope to within 10%, honing in on the contribution of galaxies to reionization.

2) The colors of faint galaxies: The HFF will probe low-metallicity stars at high- $z$ . The cluster fields will yield galaxies with intrinsic absolute magnitudes fainter than -17, where we expect to see low-metallicity star formation, and the blank fields will increase the numbers of  $m=28-29$  galaxies by 3x, strongly reducing the uncertainty on their mean color.

3) The abundance of galaxies at  $z=9$ : The inclusion of the F140W filter in all HFF observations will allow the robust two-band detection of  $z=9$  galaxies. Using a larger sample over a wider dynamic range in luminosity, we will investigate the apparent discrepancy between previous studies at  $z=9$  based on the HUDF.

With funding to carry out this work on the complete dataset, we will be able to place the most robust constraints yet on these high- $z$  galaxies, maximizing the output from the HFF program in advance of JWST.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14301

Proposal Category: AR  
Scientific Category: Hot Stars  
ID: 14301  
Program Title: A Robust Method for Modeling 3-D HST/STIS Data Cubes Using Time-Dependent 3-D Simulations  
  
Principal Investigator: Thomas Madura  
  
PI Institution: NASA Goddard Space Flight Center

We cannot send probes to study astronomical (extrasolar) objects from the multiple viewing angles needed to provide us with 3-D spatial information. However, spatially-resolved spectra can be obtained using the HST/STIS, producing a 3-D (2-D spatial + 1-D wavelength or velocity) data cube. The underlying 3-D structure and properties of a system can then be determined by comparing observational data cubes with synthetic cubes generated using 3-D time-dependent simulations. Many extended objects have been mapped with STIS, including galaxies, jets from young stars, and the colliding stellar winds in Eta Car. Still, a basic analysis framework and robust methods to statistically measure the degree of similarity between synthetic and observed data cubes does not exist. We propose to use 3-D hydrodynamical and 3-D radiative transfer simulations of Eta Car's binary colliding winds to create synthetic observations of forbidden emission lines for comparison to multi-epoch HST/STIS data cubes of Eta Car's central colliding winds. The goals are to (1) perform the first robust comparison of observational to synthetic HST/STIS data cubes of a time-varying (on a human life timescale) and spatially-extended astrophysical system, (2) present a framework that can be extended to quantitatively model the 3-D structure of similar astrophysical systems observed with HST/STIS, and (3) better determine the stellar properties of Eta Car's binary companion and constrain any recent mass-loss changes in the system. The field of astronomy has invested more than one billion US dollars in hardware for multi-D data acquisition and critically needs new methods to properly model and interpret such data.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14302

Proposal Category: AR  
Scientific Category: Cosmology  
ID: 14302  
Program Title: A Legacy Archive Program Providing Optical/NIR-selected Multiwavelength Catalogs and High-level Science Products of the HST Frontier Fields

Principal Investigator: Danilo Marchesini

PI Institution: Tufts University

We propose to construct public multi-wavelength and value-added catalogs for the HST Frontier Fields (HFF), a multi-cycle imaging program of 6 deep fields centered on strong lensing galaxy clusters and 6 deep blank fields. Whereas the main goal of the HFF is to explore the first billion years of galaxy evolution, this dataset has a unique combination of area and depth that will propel forward our knowledge of galaxy evolution down to and including the foreground cluster redshift ( $z=0.3-0.5$ ). However, such scientific exploitation requires high-quality, homogeneous, multi-wavelength (from the UV to the mid-infrared) photometric catalogs, supplemented by photometric redshifts, rest-frame colors and luminosities, stellar masses, star-formation rates, and structural parameters. We will use our expertise and existing infrastructure - created for the 3D-HST and CANDELS projects - to build such a data product for the 12 fields of the HFF, using all available imaging data (from HST, Spitzer, and ground-based facilities) as well as all available HST grism data (e.g., GLASS). A broad range of research topics will benefit from such a public database, including but not limited to the faint end of the cluster mass function, the field mass function at  $z>2$ , and the build-up of the quiescent population at  $z>4$ . In addition, our work will provide an essential basis for follow-up studies and future planning with, for example, ALMA and JWST.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14303

Proposal Category: AR  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14303  
Program Title: Multi-Waveband Photometric Catalogs for the Hubble Frontier Field Clusters and their Parallel Fields  
  
Principal Investigator: Bahram Mobasher  
  
PI Institution: University of California - Riverside

Using the multi-waveband photometric data of the Hubble Frontier Field (HFF) clusters and their parallel fields, taken by the HST/ACS and WFC3, we propose to generate self-consistent photometric catalogs of galaxies in these fields. We combine the ACS images taken with different filters and use the stacked image to select the galaxies, minimizing any wavelength-dependent bias in the catalog. We apply the Template FITting (TFIT) method to perform self-consistent photometry between images from different detectors (ACS, WFC3, IRAC), allowing for differences in the PSFs and resolutions. This provides multi-waveband photometric catalogs spanning the wavelength range ACS (optical), WFC3 (near-infrared) and Spitzer/IRAC (3.6 and 4.5 microns). The self-consistent photometric catalog will then be used to estimate the photometric redshift, stellar mass, rest-frame color, extinction and star formation rate for individual galaxies. We will undertake a spectroscopic campaign to obtain spectroscopic redshifts (and diagnostic lines) for galaxies in the HFF clusters and their parallel fields. We have already started these observations with a successful observing runs. All the photometric catalogs and the spectra (including the spectroscopic redshifts) will be provided to the community soon after they were obtained and passed the quality check. We request funding for 18 months to support a graduate student to carry out this work. All the routines and pipelines needed for this program are already developed and tested.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14304

Proposal Category: AR  
Scientific Category: Cosmology  
ID: 14304  
Program Title: The intra-cluster light as seen by the Hubble Frontier Fields

Principal Investigator: Mireia Montes

PI Institution: Yale University

Far from being completely understood, the diffuse component of galaxy clusters is a crucial piece in the puzzle of cluster formation and evolution. Measuring its stellar population properties makes it possible to peer into the past and discern the evolutionary mechanisms of galaxy clusters. Observing this diffuse light, or intra-cluster light (ICL), is challenging as it can only be observed at very low surface brightness ( $\mu_V > 26$  mag/arcsec<sup>2</sup>). Consequently, our understanding of this light is still at early stages. To perform a major step forward in our understanding of the ICL, we will exploit the HST Frontier Fields (HFF) dataset. The combination of the deepest images of clusters ever taken by the HST with multi-wavelength coverage (particularly in the near-infrared) will allow us to accurately determine the fraction of stellar mass, the age and metallicity of the ICL with unprecedented accuracy in 6 massive galaxy clusters. A comprehensive analysis of the HFF clusters will determine what mechanisms shaped the formation of the ICL and will constrain the assembly epoch of the massive HFF galaxy clusters.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14305

Proposal Category: AR  
Scientific Category: Cosmology  
ID: 14305  
Program Title: Nonlinear evolution predictions for dark matter substructure, and predictions for gravitational lensing probes  
  
Principal Investigator: Leonidas Moustakas  
  
PI Institution: Jet Propulsion Laboratory

Understanding the observable astrophysical consequences of the fundamental properties of dark matter is essential for evaluating diverse observations by HST, from within streams and dwarf galaxies in or near the Milky Way, to effects on the formation and evolution of structure in cosmologically distant galaxies and clusters. We have developed statistical characterizations of the substructure within dark matter halos over a wide range of masses and for a variety of assumptions about the physics of the dark matter particle, to supplement and complement N-body simulations, which are challenged to reach the relevant mass scales. It is on these small scales where the interesting dark matter particle physics is expected to leave a detectable trace. Our objectives are: 1. Provide the theoretical toolkit and suites of simulations that will be broadly useful for the HST community in analyzing observations in several key frameworks (local Milky Way galaxy-type structures; lens galaxies and clusters of galaxies at a range of cosmic epochs from  $z \sim 0.1$  through  $z \sim 2$ ); and 2. By taking these sets of deliverables and running each realization through the gravitational lensing code of Col Keeton, derive diagnostics that may distinguish between or rule out dark matter scenarios.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14306

Proposal Category: AR  
Scientific Category: Unresolved Star Formation  
ID: 14306  
Program Title: Enhancing the Frontier Field Legacy by Combining the Power of HST and the Jansky VLA  
  
Principal Investigator: Eric Murphy  
  
PI Institution: California Institute of Technology

Deep HST and Spitzer imaging of the Frontier Fields provides unprecedented constraints on the fundamental properties of galaxies out to very high redshifts ( $z > 8$ ) by leveraging massive clusters that can be used to magnify extremely faint systems. We propose to enrich this legacy by providing unique measurements derived from deep 3 and 6 GHz images obtained as part of our ongoing Jansky Very Large Array (JVLA) Frontier Fields Legacy Program. These radio images each have a depth of 1  $\mu$ Jy and reach a resolution of 0.3 arcsec (similar to WFC3) at 6 GHz. Consequently, these data will provide unobscured, integrated star formation rates out to  $z \sim 8$ ; radio morphologies of  $L^*$  galaxies out to  $z \sim 3$ ; sub-kpc resolution for highly magnified sources at  $z > 1$ ; and AGN diagnostics via polarization maps and radio spectral indices. Together with the HST and Spitzer data, these new radio images will inform a variety of extragalactic topics, including the importance of dusty star-forming galaxies at high redshift; the evolution of supermassive black holes; the nature of starburst galaxies out to  $z \sim 3$ ; and the rapid evolution of galaxies in the lensing clusters themselves. To ensure that the legacy of this combined data set is realized, we will publicly distribute radio maps, radio source catalogs, band-merged catalogs, a morphological analysis of the multi-wavelength HST images for all radio sources, and multi-band cutouts centered on the radio detections.

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**Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)**

14307

**Proposal Category:** AR  
**Scientific Category:** Cosmology  
**ID:** 14307  
**Program Title:** Turbulent Mixing and Thermal Instability in the Circumgalactic Medium

**Principal Investigator:** Siang Oh

**PI Institution:** University of California - Santa Barbara

The cycle of baryons into and out of galaxies is a crucial link between cosmological scales and the fundamental processes of galaxy and star formation. However, only a small fraction of the baryons in the Universe resides as gas within galaxies – much smaller than what theoretical models predict. Recent results with the Hubble Space Telescope suggest that a large fraction of the baryons that do not sit within galaxies still reside in their vicinity, in the so-called circumgalactic medium (CGM). Gas there arises both from cosmological infall and galactic winds.

The goal of this proposed research is to carry out state-of-the-art idealized simulations with much more micro-physics (e.g. magnetic fields, thermal conduction, radiative cooling, turbulence) and higher resolution than cosmological simulations. We will explore the impact of hitherto neglected microphysical processes and formulate subgrid recipes for cosmological simulations. We focus on the following aspects: (i) Formation of cold gas: thermal instability in a turbulent medium; (ii) Survival of cold gas: the effects of magnetic draping; (iii) Non-thermal pressure support in cold gas; (iv) Formation of warm OVI gas: turbulent mixing and conduction; (v) Effectiveness of metal mixing; size of metal blobs.

The results of this research will advance our understanding of the life cycle of baryons, and shed light on key questions at the nexus of cosmology, galaxy, and star formation. It will provide important theoretical interpretation of HST/COS spectra of absorption line systems in the CGM.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14308

Proposal Category: AR  
Scientific Category: AGN/Quasars  
ID: 14308  
Program Title: Characterizing group baryons and galaxies through EAGLE zoom simulations

Principal Investigator: Benjamin Oppenheimer

PI Institution: University of Colorado at Boulder

We propose to run a series of zoom renormalization simulations of group-sized halos using the EAGLE (Evolution and Assembly of GaLaxies and their Environments) code integrated with our non-equilibrium module to follow the time-dependent ionization and cooling of individual ionic species observed by the Cosmic Origins Spectrograph (COS). Starting with a suite of zooms that reproduce important properties of galaxies and the circumgalactic medium, we aim to extend the zooms to the group scale by resimulating halos  $M_{\text{vir}}=10^{12.7}-10^{14.0}$  Msol. We will focus on the physical properties of the intra-group medium (IGrM) that can be constrained via COS absorption line measurements that find OVI, HI (narrow and broad), and other metal lines at sight lines impacting between 0-2 Rvir. The science goals of our simulation-observation confrontation are two-fold: 1) to understand the role of the IGrM in transforming and quenching galaxies, and 2) to find a new handle on the baryon content and distribution in and around groups. The first goal emphasizes the importance of the group environment in galaxy formation in the highly clustered evolved Universe. The second goal is important in the 'era of precision cosmology' where dark energy surveys require accurate modeling the effects of galactic feedback on the baryon distribution.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14309

Proposal Category: AR  
Scientific Category: Solar System  
ID: 14309  
Program Title: A High-Precision Archival Measurement of the Kuiper Belt Luminosity Function

Principal Investigator: Alex Parker

PI Institution: Southwest Research Institute

The luminosity function of the Kuiper Belt is a powerful tracer of planetesimal formation and evolution in the outer solar system. Its faint-end behavior has been difficult to determine accurately, due to the paucity of surveys sufficiently sensitive to objects in the relevant luminosity regime. The 194-orbit HST Large Program GO 13633 has nearly tripled the number of known low-inclination Kuiper Belt Objects fainter than  $H \sim 10$ ; however, this Large Program received no support for calibration, and has not been calibrated sufficiently to use these new KBOs to accurately measure the faint-end behavior of the luminosity function. Here we propose to perform this calibration, and re-analyze the data in order to search for high-inclination KBOs as well. With the proposed calibration and re-analysis, this archival HST data is capable of ruling out a state of collisional equilibrium for small Kuiper Belt objects, a substantial step forward for understanding the history of planetesimal formation and evolution in the outer solar system.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14310

Proposal Category: AR  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14310  
Program Title: The role of quenching and merging in shaping the passive galaxy population in distant clusters

Principal Investigator: Gregory Rudnick

PI Institution: University of Kansas Center for Research, Inc.

For decades we have known that galaxy clusters had a lower fraction of passive galaxies in the past. However, despite intense study we still do not know how or when passive galaxies became passive and what role the cluster environment plays. Key to making progress in this endeavor is bringing the study of clusters to  $z>1$ , where the massive passive galaxies entered their last epoch of star formation. This is just now possible as the number of  $z>1$  clusters is burgeoning, as is the ability to select and study passive galaxies within them, largely thanks to HST observations. We propose to use archival HST imaging of 22 galaxy clusters at  $z>1$  to systematically study how the passive galaxy population in the densest environments has grown over the last 10 billion years. Using photometry that spans the 4000 Ang break at each redshift, we will isolate passive member galaxies and measure their rest-frame optical luminosity and stellar mass functions. We will match clusters with their likely descendants at all redshifts using the predicted growth of their dark matter halos and will constrain the evolution both in the mass functions and luminosity functions. We will use the HST imaging to compute internal stellar mass density, which has been shown to be an excellent predictor of intrinsic quenching. Finally, using models for intrinsic and environmental quenching and merging that we have already developed, we will determine the relative importance of these processes in growing and shaping the passive galaxy population in clusters.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14311

Proposal Category: AR  
Scientific Category: Cosmology  
ID: 14311  
Program Title: Emission Line Galaxy Constraints from HST: Towards Accurate Forecasts  
for WFIRST and Euclid  
Principal Investigator: Claudia Scarlata  
PI Institution: University of Minnesota - Twin Cities

Dark energy is one of the most important unsolved problems in cosmology today. The planned, mutually complementary WFIRST and Euclid mission galaxy redshift surveys will use H $\alpha$ - and [OIII]-selected emission line galaxies as tracers of the large scale structure at  $1 < z < 2$  (H $\alpha$ ) and  $1.7 < z < 2.7$  ([OIII]). To optimize these redshift surveys for the study of dark energy, it is critical to have a reliable and sufficiently precise knowledge of the expected numbers of H $\alpha$  galaxies in the survey volume. Additionally, WFIRST and Euclid's sample of emission-line galaxies will, like all slitless spectroscopy surveys, be affected by a complex selection function that depends on galaxy size and luminosity, line equivalent width, and redshift errors arising from the mis-identification of single emission-line galaxies. To maximize the science return of these redshift surveys, we need to be able to account for these effects in the forecast predictions.

Here we propose to combine three slitless spectroscopic WFC3-IR datasets -- The CANDELS supernova follow-up, 3D-HST+AGHAST, and the WISP survey -- to: (1) obtain the most accurate estimate of the H $\alpha$  and [OIII] luminosity functions in the redshift ranges 0.7 - 1.6 and 1.2 - 2.2, respectively, (2) constrain the continuum luminosity, galaxy size, and EW distribution functions for line-emitters, and (3) quantify the expected number of contaminating redshifts from misidentified single emission lines.

Our proposed analysis is of great relevance to ensure success of the planned WFIRST and Euclid missions.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14312

Proposal Category: AR  
Scientific Category: AGN/Quasars  
ID: 14312  
Program Title: Constraining the Merger Fraction of Quasars with High-Resolution HST Imaging

Principal Investigator: Jan-Torge Schindler

PI Institution: University of Arizona

Observations and simulations both strongly suggest that AGN activity is triggered by one of two mechanisms. Either major mergers of gas-rich galaxies or secular disk instabilities within a galaxy force gaseous inflows and thus fuel the black hole in the center. HST imaging of AGN in the CANDELS and GOODS fields has recently been used to support the secular model in statistical significant samples of moderate luminosity AGN at redshifts  $z < 2.0$ . However quasars, at higher luminosity and accretion rate, may instead be mainly triggered by the merger scenario which naturally allows for the extreme fueling rates. To date no such statistical study exists for the quasar population. We propose to build a large database of quasar images, selected from the HST archive, and use it to statistically constrain the major merger pair fraction of quasars above redshifts of  $z = 0.5$  to fill this gap. Using ACS, WFC3 and WFPC2 imaging, we will PSF subtract the quasar and its host galaxy in search for close companions. This technique has been successfully applied by our team to look for close companions in a small HST sample. This archival program will build the largest database of quasar imaging, comprising  $\sim 1000$  quasar images observed in past HST programs, the majority of which do not have quasars as their primary targets, thus selected in an unbiased manner. We will not only be able to constrain the triggering mechanism of quasars, but also study the quasar host properties for indications of mergers. As a byproduct we will discover new lensed quasars and apply our findings to the quasar luminosity function. The final database will be made publicly available for further investigations.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14313

Proposal Category: AR  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14313  
Program Title: Black Holes and Central Mass-to-Light Ratios in Low Mass Early-Type Galaxies

Principal Investigator: Anil Seth

PI Institution: University of Utah

Nuclear X-ray sources show that many low-mass early-type galaxies have central supermassive black holes. However, apart from the unusual Local Group galaxy M32, none of these black holes have measured dynamical masses. We show that using only existing data—archival HST imaging and published ground-based kinematic measurements—we can estimate the black hole masses and central mass-to-light ratios of a sample of 46 low-mass early-type galaxies. We will use these measurements to explore black hole demographics and scaling relations in this unexplored area of parameter space. We will also test the hypothesis that ultra-compact dwarf galaxies are the tidally stripped remnants of such low-mass early type galaxies.



Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14314

Proposal Category: AR  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14314  
Program Title: Spatial Modeling of the Topology of He II Reionization

Principal Investigator: J. Shull

PI Institution: University of Colorado at Boulder

The reionization of He II near redshift  $z = 3$  marks the last major phase change in the intergalactic medium. Spatially rare quasars, with their harder UV spectra, are expected to be the primary sources for He II reionization. Our HST-AR-Theory project will use the Eulerian N-body + hydrodynamics code Enzo to simulate the topology, physical conditions, and evolution of the He II reionization epoch. Our important new modeling advance is to insert discrete photoionizing sources and perform radiative transfer using the flux-limited diffusion module. Properties of He II in the IGM and in QSO proximity zones can now be constrained spectroscopically by the Cosmic Origins Spectrograph: time evolution of the global He II and He III fractions and inhomogeneity of ionized regions in the IGM and around QSOs. We will compare synthetic quasar sightlines to existing observations, study the quasar population responsible for He II reionization, and investigate the impact of QSO lifetimes, luminosity functions, and other parameters that are consistent with current observations.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14315

Proposal Category: AR  
Scientific Category: Quasar Absorption Lines and IGM  
ID: 14315  
Program Title: Can thermal instabilities drive galactic precipitation and explain observed circumgalactic structure?  
Principal Investigator: Devin Silvia  
PI Institution: Michigan State University

Understanding the complex nature of the circumgalactic medium (CGM) has been a target of numerous research efforts, both observationally and theoretically. While significant progress has been made in probing the structure and thermodynamic state of the CGM through the detection of metal line absorption systems using the Hubble Space Telescope (HST), a complete picture of the physical mechanisms that produce the observed properties does not yet exist. Recent theoretical work has suggested that a delicate balance between radiative cooling and thermal feedback determines whether or not the CGM is capable of sustaining a stable, multiphase medium that would allow cool clouds to precipitate out of the galactic halo. This new theoretical framework may provide the explanation for many observational results. In this project, we will determine whether or not this elegant and simple precipitation model can be supported by physics-rich numerical simulations of isolated galaxies. We will use our simulations to gain a deeper understanding of the precipitation model and explore the ionization and temperature structure of the CGM. Our analysis will include the comparison of realistic synthetic spectra to those produced by HST, using the newly-developed Trident software package.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14316

Proposal Category: AR  
Scientific Category: Hot Stars  
ID: 14316  
Program Title: Are LBVs in Andromeda as Isolated as LMC LBVs? Critical Test of a Massive Star Paradigm  
  
Principal Investigator: Nathan Smith  
  
PI Institution: University of Arizona

We propose to use data from the Panchromatic Hubble Andromeda Treasury (PHAT) survey to study the environments of luminous blue variables (LBVs) in M31. LBVs are thought to mark the immediate post-main-sequence phase of massive O-type stars, and are presumed to drive the mass loss to become H-poor Wolf-Rayet (WR) stars. Thus, one expects LBVs to be associated with other main-sequence O-type stars, most of which reside in clusters. While ground-based images of M31 have been able to identify many LBVs because they are bright and easy to recognize, ground-based data lack the sensitivity to detect individual main-sequence O-type stars. The PHAT images can easily do this, especially since these data include UV images that will pick out O-type stars. The reason we are motivated to do this study is because we have recently examined the locations of LBVs and O stars in the Milky Way and Magellanic Clouds, and have found a stunning result (Smith & Tombleson 2015). With the exception of Eta Carinae, LBVs systematically avoid O stars, and they are farther from O stars than the WR stars that are supposedly their progeny. LBVs tend to be in the middle of nowhere, and about a third of them are more than 100 pc from any O star. This degree of isolation would strongly disprove our current paradigm of massive star evolution, which relies on LBV mass loss to turn massive O-type stars into WR stars. The alternative is that binary evolution dominates their fate, and it is likely that kicks from a companion's supernova enhance their isolation. To confirm this important paradigm shift, we need to see that the trend holds in the nearest large spiral galaxy.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14317

Proposal Category: AR  
Scientific Category: Resolved Star Formation  
ID: 14317  
Program Title: The Orion Experiment

Principal Investigator: Jonathan Tan

PI Institution: University of Florida

We propose to carry out a systematic theoretical exploration of the dynamical evolution of a star cluster that is designed to resemble the Orion Nebula Cluster (ONC) and its surroundings as closely as possible. This includes matching the currently observed stellar masses, spatial distributions, velocity distributions, binary properties and background gas potentials. These properties are constrained by a wealth of observational data, especially HST Treasury program data and SDSS-APOGEE data. We will utilize modified version of the NBODY6 and AMUSE codes for these experiments. The main goal is to understand how the present stellar properties constrain theories of star and star cluster formation, including the degree of initial virialization of the stars, their initial spatial and kinematic substructure, and the rate at which they form compared to the free-fall time of the cluster. We will also explore whether massive stars tend to form relatively early or late compared to lower-mass stars and whether they tend to form closer to the cluster center.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14318

Proposal Category: AR  
Scientific Category: Unresolved Stellar Populations and Galaxy  
ID: 14318  
Program Title: The Nature of Compact Stellar Systems in Massive Galaxy Clusters Using the Hubble Frontier Fields  
  
Principal Investigator: Elisa Toloba  
  
PI Institution: University of California - Santa Cruz

We propose to use the exceptionally deep images of the Hubble Frontier Fields (HFF) observations of Abell 2744 and MACSJ0416.1-24.03 ( $z=0.31$  and  $0.40$ ) to characterize the first ever compact stellar systems seen beyond a Gigaparsec in distance: globular clusters (GCs), ultra-compact dwarf galaxies (UCDs), dwarf early-type galaxy's nuclei (dEN), and compact early-type galaxies (cEs) within the clusters themselves. These two clusters are extraordinarily rich in the number and variety of galaxies they contain. Both exhibit multiple peaks in the dark matter, X-ray, and galaxy density distributions, suggesting the we are witnessing an ongoing collision of several massive clusters. Using these compact stellar systems as fossil records of the violent interactions that shaped these massive clusters and the galaxies in them, we will gain new insight of cluster formation processes and will explore the connection between star clusters and faint compact galaxies. We will model and remove the stellar light of the cluster galaxies in all seven optical and infrared bands to uncover the large hidden population of GCs and other compact stellar systems. We will use this extraordinarily deep multiwavelength dataset to analyze the spatial distribution and color-based stellar populations to explore the nature of these compact systems, the universality of their formation efficiency, probe their formation scenarios, and use them as possible tracers of the complex dynamical histories of these clusters. We will release the background subtracted images and multiwavelength photometric catalogs for all sources in both clusters. This is a key dataset optimal for a wide range of legacy science.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14319

Proposal Category: AR  
Scientific Category: Resolved Stellar Populations  
ID: 14319  
Program Title: Exploiting the Archive for TRGB Distances

Principal Investigator: R. Tully

PI Institution: University of Hawaii

Tip of the red giant branch (TRGB) distance measurements with HST constitute a foundational component of the Cosmicflows compilation of extragalactic distances. Cosmicflows is a program to determine the Hubble Constant, map peculiar velocities, and recover the underlying matter density field. With ACS on HST, TRGB distances can be established with rms 5% accuracy for essentially any galaxy within 10 Mpc. Presently between our observations and archival material from past years we have TRGB results for 384 galaxies. In cycle 22, 68 additional galaxies are being observed. Another half dozen complicated cases from earlier years await exploitation. While most of this material will have been reasonably treated by others, we argue that it is important that the ensemble be analyzed in a consistent manner to minimize systematics in the measurement of distances. The Pop II based absolute scale of the TRGB distances will be reviewed. The full collection of HST material related to TRGB observations for almost 500 galaxies will be ported to the Mulkulski Archive for Space Telescopes.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14320

Proposal Category: AR  
Scientific Category: Extra-Solar Planets  
ID: 14320  
Program Title: Characterizing the Galactic and Extragalactic Background of Exoplanet Direct Imaging Targets  
Principal Investigator: Margaret Turnbull  
PI Institution: SETI Institute

There is a growing impetus for spacebased missions to directly image and characterize Earth-like, and larger, exoplanets orbiting nearby sunlike stars. The target lists for all such missions form a well-defined sample that, by astrographical and astrophysical necessity, cannot change except around its periphery according to the details of mission performance. Advance characterization of confounding background sources in near-future planet hunting fields has the potential to critically impact target selection and observing strategy. HST offers the most sensitive means and highest angular resolution with which to understand the faint background surrounding these important targets. To help lay the groundwork for exoplanet imaging missions, we propose an archival HST wide field imaging proposal to characterize the Galactic and extragalactic background for the highest priority exoplanet imaging targets. For the 77 highest priority targets of recent mission concept studies ( $d < 15$ pc), 25 have wide field imaging in the Hubble Legacy Archive. The stars are typically high proper motion with substantial displacement between the archival data and their future locations. We will identify where the present and near-future target fields overlap with this archival data, and which target fields require additional observations. We will then carry out a detailed analysis of star and galaxy counts and colors for the environments of the target stars. After demonstrating the utility of the HST archival data in preparing for direct imaging studies, this work is expected to lead to a Legacy proposal to study all targets in detail and propose for additional observations where necessary.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14321

Proposal Category: AR  
Scientific Category: Cool Stars  
ID: 14321  
Program Title: Improving UV Continuous Opacities and Model Spectra for Cool Stars

Principal Investigator: Jeff Valenti

PI Institution: Space Telescope Science Institute

We will use existing high-resolution STIS and COS spectra of cool stars with accurately measured angular diameters to test UV continuous opacity routines in widely-used spectrum synthesis codes, including our own SME package. Our preliminary analysis of the Sun and alpha Cen A shows that the flux level in strong line cores is well modeled, but the flux level in the "continuum" between strong lines is too bright by factors of two or more in the UV. We will incorporate modern cross-section calculations and lab measurements into our continuous opacity package. We will validate these changes by comparing new synthetic flux spectra with observed spectra of inactive stars, getting the necessary scale factor from accurately measured angular diameters. With new synthetic spectra for inactive stars, we will also study how the observed UV flux excess depends on stellar activity. We will assess the impact of remaining errors in model stellar spectra by computing two sets of exoplanet photochemistry models, one illuminated by observed stellar spectra and the other illuminated by our new model spectra. We will identify which errors in our model stellar spectra have the largest impact on abundances of spectroscopically-active photochemical species for a variety of exoplanet types. This feedback will help prioritize future work on opacities and stellar models. This project will help build new connections between the atomic physics, stellar spectroscopy, and exoplanet atmosphere communities.



Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14322

Proposal Category: AR  
Scientific Category: Resolved Stellar Populations  
ID: 14322  
Program Title: Finding needles in haystacks: intermediate-mass black holes in Galactic globular clusters  
  
Principal Investigator: Laura Watkins  
  
PI Institution: Space Telescope Science Institute

We propose to improve the performance of existing dynamical-modelling tools, and then to use them to place limits on intermediate-mass black hole (IMBH) masses in a set of Galactic globular clusters.

The existence of IMBHs is a topic with high astrophysical impact, however all reported detections so far have been disputed as neither data nor models have been sensitive enough to draw firm conclusions. Globular clusters are prime host candidates; to detect IMBHs in their crowded central regions requires extremely precise proper-motion measurements. This is only possible with the exquisite astrometric accuracy of HST.

We have high-precision HST proper-motions for a set of Galactic globular clusters. These exceptional datasets have the potential to definitively address the issue of IMBHs, however, no existing modelling tools match their quality. Only with the modelling improvements we propose here will we correct that imbalance and make IMBH detection possible. This work is critical to maximise the potential of the HST datasets.

We will generate mock datasets from N-body simulations of globular clusters and use them to improve the sensitivity of existing discrete dynamical models to the kinematic signals from IMBHs. With the tailored models, we will then investigate whether a mass-segregated population of stellar remnants may masquerade as an IMBH. Finally, we will apply the models to our existing HST proper motion datasets for a set of Galactic globular clusters to measure IMBH masses. The theoretical phase of the project is vital for the success of the subsequent data analysis, and will serve as a benchmark for future observational campaigns with HST, JWST and beyond.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14323

Proposal Category: AR  
Scientific Category: ISM and Circumstellar Matter  
ID: 14323  
Program Title: An Archival Survey of Trace Neutral Interstellar Species: Comparing Diagnostics of Physical Conditions  
Principal Investigator: Daniel Welty  
PI Institution: University of Chicago

Trace neutral interstellar species (with ionization potentials  $< 13.6$  eV) can be used to estimate local physical conditions ( $n_e$ ,  $n_H$ ,  $T$ , radiation field) – e.g., via analyses of C I fine-structure excitation and of the ionization balance. Apart from surveys of C I, however, few accurate measurements are available for other trace species with lines in the UV (Mg, Si, S, P, Cl, Zn). For the few sight lines where multiple, well-determined X I/X II ratios are available, however, the inferred  $n_e$  can differ by factors of 30; consideration of grain-assisted and dielectronic recombination has not resolved the discrepancies. Moreover, the  $n_H$  inferred from the commonly used Ca I/Ca II ratio are systematically higher, by factors of 10–100, than the values obtained from C I fine structure. Some additional factor(s) must commonly and significantly affect the ionization balance in the ISM. We propose to substantially increase the sample of accurate measurements of Mg I, Si I, S I, P I, Cl I, and Zn I, using archival STIS and GHRS echelle spectra of ~150 sight lines; these will be combined with large samples of Li I, Na I, K I, Ca I, and Fe I derived from optical spectra. The primary goal is to compare multiple diagnostics of interstellar physical conditions – e.g., the densities inferred from various X I/X II ratios with those obtained from C I fine-structure excitation and C<sub>2</sub> rotational excitation – to determine whether they are consistent with each other and with cloud models. The derived  $N(X I)$  will also be used to investigate the ionization properties of the diffuse interstellar bands and to test the generally assumed dependence of depletions on local density.

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Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14324

Proposal Category: AR  
Scientific Category: Resolved Stellar Populations  
ID: 14324  
Program Title: Finding and Aging the Population of High-Mass X-ray Binaries in M33

Principal Investigator: Benjamin Williams

PI Institution: University of Washington

We propose to find the optical counterparts for at least 40 high-mass X-ray binaries (HMXBs) in M33 using archival HST imaging data. We will align the data to the deep Chandra X-ray catalog to search for optical counterpart candidates to the X-ray sources. The optical morphology and photometry of these counterparts will identify which X-ray sources are most likely to be HMXBs. The colors of the counterpart stars will allow each HMXB to be typed. Because HMXBs are young systems, we will measure the recent star formation histories (SFHs) of their surrounding populations to determine their ages. We will then compare the distribution of ages to those we've measured for other nearby galaxies to look for patterns with metallicity and star formation rate, and we will compare the distribution to those predicted by binary formation and evolution models. This project will yield state-of-the-art observational constraints on population synthesis models for interacting binary stars.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14325

Proposal Category: AR  
Scientific Category: Resolved Stellar Populations  
ID: 14325  
Program Title: Measuring the Upper End of the Supernova Progenitor Mass Distribution in M83

Principal Investigator: Benjamin Williams

PI Institution: University of Washington

We propose to measure the progenitor masses for a large sample of supernova remnants (SNRs) in M83. With a high supernova rate (6-7 per century) and more identified SNRs (>300) than any other galaxy, the nearby grand-design spiral M83 is an ideal target for the study of SNR progenitors. Deep HST images obtained recently with ACS and WFC3 cover most of the galaxy. Using these images, we will age-date the stellar population associated with each SNR and derive a corresponding progenitor mass. We have used the same technique previously to measure the progenitor masses for 17 historic SNe, 82 SNRs in M31, and 33 SNRs in M33. The M31 and M33 studies suggested a dearth of progenitors with initial masses >20 solar masses. M83 has a much higher SFR than the galaxies used in our earlier studies, which greatly increases the chances of finding progenitors of higher mass, and will provide much better constraints on the distribution of high-mass progenitors than was possible previously.

Cycle 23 Abstract Catalog  
(Based on Phase I Submissions)

14326

Proposal Category: AR  
Scientific Category: Cosmology  
ID: 14326  
Program Title: Observational Diagnostics for High-Redshift Galaxies with Massive Black Hole Seeds

Principal Investigator: John Wise

PI Institution: Georgia Tech Research Corp.

Over 40 bright quasars powered by supermassive black holes (SMBHs) with estimated masses greater than a billion solar masses have been discovered at redshifts greater than 6. To explain the rapid assembly of these SMBHs, massive seed black holes and/or (super-)Eddington accretion are required. In recent work, we have shown that a galaxy forming around a massive seed black hole has different stellar properties than typical first-generation galaxies, caused by X-ray radiative feedback from the central black hole. We propose to construct observational diagnostics from our radiation hydrodynamics simulations to test different black hole seeding scenarios. The primary goal of this proposal is to compute the following synthetic observables for these galaxies: (1) spectral energy distributions and associated imaging and photometry, (2) emission line profiles and strengths in the rest-frame UV and optical, (3) evolution tracks in color-color diagrams and emission line measures, and (4) rest-frame IR/sub-mm predictions. These products will provide guidance when searching for galaxies that initially hosted a massive black hole seed in the Hubble Extreme Deep Field, Frontier Fields, and future JWST observations, placing further constraints on the origins of the  $z = 6$  quasars. We will make all of the analysis tools and data products publicly available.

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