Cycle 21 Abstract Catalog
(Based on Phase I Submissions)

Proposal Category: AR
Scientific Category: Resolved Stellar Populations
ID: 13232
Program Title: Main Sequence Star Counts as a Probe of IMF Variations with Galactic Environment

Principal Investigator: Joshua Adams

PI Institution: Observatories of the Carnegie Institution of Washington

There are many theoretical reasons to expect that the stellar initial mass function (IMF) may not be universal across all types of galaxies and eras of star formation, but the empirical evidence for IMF variations is only now becoming compelling. Recent work using multiple complementary indirect methods is converging on the result that more massive, higher metallicity systems contain more bottom-heavy IMFs. Geha et al. (2013) and Kalirai et al. (2013) have just obtained similarly dramatic results with a much more direct and model-independent method: counting stars below the oldest main sequence turnoff in the closest galaxies to the Milky Way. Reliable IMF measurements using this technique are available in the literature for only four galaxies: the Milky Way, the Small Magellanic Cloud, and two ultra-faint dwarfs, which show extremely bottom-light IMFs. We propose to use identical analysis techniques on archival WFPC2, ACS, and WFC3 imaging to determine the IMF from 0.5 to 0.75 Msun in four additional galaxies: the Large Magellanic Cloud, Sagittarius, Ursa Minor, and Draco. These measurements will substantially improve our knowledge of the dependence of the IMF on different galaxy properties such as metallicity and mass, providing new constraints on the physics responsible for IMF variations.

Proposal Category: AR
Scientific Category: AGN QUASARS
ID: 13233
Program Title: The COS revolution of AGN outflow science

Principal Investigator: Nahum Arav

PI Institution: Virginia Polytechnic Institute and State University

HST/COS has opened a vast new discovery space for quasar outflow science. Specifically, it provides high quality FUV spectra covering the diagnostic-rich 500-1050 Angstrom rest-frame of medium redshift objects. We have recently published a series of papers, based on the analysis of data supported by our concluded COS archive program, in which we reported: a) a new population of very high ionization outflows, b) robust cases of two-ionization-phase outflows, which are the missing link between UV AGN outflows and x-ray warm absorbers, and most importantly c) spectral diagnostics that allowed us to determine the distances of 2 such outflows from the central source, and thus their tomography and energetics. These findings demonstrate that quasar outflows have sufficient energy to confirm the theoretical predictions of the significance of AGN feedback processes, and go a long way towards answering some of the fundamental questions in the field of AGN outflows that have been around for more than 20 years.
Here we propose a continuation of this very successful archive program. Thus far we've analyzed about 300 COS G130M and G160M orbits of AGN observations. There are roughly 600 additional orbits that satisfy our criteria and will be available by the end of this year, with an additional 300 orbits in the following year. Based on our published survey, we expect that these 900 orbits will yield 20-30 additional very-high ionization outflows and 4-6 cases of distance determinations, all in cosmologically important luminous-quasars.

Proposal Category: AR
Scientific Category: Cosmology
ID: 13234
Program Title: Rest-Optical Morphology of 2<z<3 Lyman Alpha Emitters: Comparison with Rest-UV and Other High-redshift Galaxies

Principal Investigator: Nicholas Bond
PI Institution: NASA Goddard Space Flight Center

Lyman Alpha Emitting galaxies (LAEs) seen at redshifts 2 and 3 are progenitors of typical present-day galaxies like the Milky Way seen in their initial stage of star formation. LAEs are younger, lower in mass, and less chemically evolved than the better-studied Lyman break galaxies (LBGs), and HST imaging probes the physical properties of these objects at sub-kiloparsec resolution.

We will use archival WFC3-NIR images of the HUDF, CANDELS GOODS-S, and ERS GOODS-S to study the rest-frame optical morphology of 66 Lyman Alpha Emitters at z=2.1 and z=3.1, along with comparison samples of star-forming BzK galaxies and Lyman break galaxies at similar redshifts. For objects with sufficient signal-to-noise, we will determine Sersic profiles, CAS (Concentration/Asymmetry/clumpinesS), and internal color dispersions. We will use an existing pipeline, which we developed and applied to rest-UV ACS images of these galaxies, enabling object-by-object comparisons of rest-optical and rest-UV morphology.

Our results will reveal the nature of star formation in low-mass high-redshift galaxies where the bulk of present-day stars were formed and will provide a crucial point of comparison to the morphology of continuum-selected galaxies studied by the CANDELS team. We will illustrate if the distribution between clumpy and/or merger-driven star formation is correlated with galaxy properties such as mass or dust extinction. Our results will also improve the interpretation of morphological studies at z>4, where only rest-UV HST images are available. It will also allow for evolutionary comparisons with rest-UV morphologies at lower redshifts that are underway from UVUDF.

Proposal Category: AR
Scientific Category: Cosmology
ID: 13235
Program Title: Breaking Cosmic Dawn: Focusing Cosmic Telescopes To Observe The z >~ 7 Universe

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

Cluster-scale gravitational lenses act as cosmic telescopes, enabling the study of intrinsically lower luminosity galaxies, which would otherwise be impossible. However, in order to use these cosmic telescopes we also need a robustly derived magnification maps and error analyses. These are essential to understand the systematic errors present in such investigations. While the STScI special call for proposals to get magnification information will provide the first-order maps, this proposal will add (i) HST ultra deep Frontier Field data (not available for the call), (ii) Keck and VLT spectroscopy, (iii) improved weak lensing treatment, and (iv) flexion analysis to produce a factor of 2 improvement in the magnification estimates. This will be a crucial legacy complement to the existing efforts to provide magnification maps for these clusters and we plan to release the improved maps to the community. By reaching fainter luminosities, with this proposal we will study the faint-end slope of the luminosity function for the highest redshift galaxies. This will

enable the study of their contribution to the bulk of ionizing photons necessary to drive reionization. Furthermore we will study the role that these galaxies play in the galaxy formation models through the measurement of their sizes. Both tasks are made possible by the powers of cosmic telescopes and our proven techniques for accurate quantification of magnification.

Proposal Category: AR
Scientific Category: Cosmology
ID: 13236
Program Title: Galaxy Evolution at the Frontier: The Rate of Galaxy Buildup Between z~11 and z~8

Principal Investigator: Larry Bradley

PI Institution: Space Telescope Science Institute

Understanding the evolution of early galaxies and their contribution to reionization has been a longstanding goal of observational astronomy. Hubble's WFC3/IR camera has revolutionized our knowledge of 7<z<8 galaxies, but we still know very little about z>~8 galaxies due to their faint luminosities (M*>~-20.3) and low volume densities. In particular, blank-field studies suggest a very dramatic buildup in cosmic star-formation rate density (SFRD) in the ~165 Myr between z~8-10. These results are in tension with lensed-field studies which suggest a smooth buildup of galaxies from z ~ 10 to 4. To distinguish between these scenarios, deeper observations are required to increase z > 9 number statistics and to reduce the significant cosmic variance due to a single blank field with sufficient depth (UDF + surrounding regions). The upcoming HST Frontier Fields (HSTFF) program will obtain ultra deep observations of both "blank" and cluster-lensed fields. The latter are more efficient for high-z searches but introduce magnification uncertainties which we have quantified and found to be subdominant to Poisson uncertainties. Based on the archival first-year HSTFF data, we will identify a large sample of ~35-54 galaxies at 8<z<12, enabling us to distinguish between the possible extremes in z>9 galaxy evolution and placing new constraints on reionization. Additionally, we will measure the rest-frame UV continuum slopes of z~6-8 galaxies to improve dust extinction estimates at high redshift, a key ingredient in SFRD measurements. We will also perform strong lensing analyses to produce some of the highest resolution cluster dark matter maps to date.

Proposal Category: AR
Scientific Category: AGN QUASARS
ID: 13237
Program Title: Rehabilitating Ultraviolet-Based Quasar Black Hole Mass Estimation

Principal Investigator: Michael Brotherton

PI Institution: University of Wyoming

Single-epoch ultraviolet spectra of quasars may be used to estimate the mass of central supermassive black hole, especially at high redshifts when this region is more conveniently observed in the optical. Virial motion is assumed, and the continuum is used to estimate the line emitting size scale, while the broad C IV profile is used to estimate the velocity of the gas. HST data have been used to calibrate such a C IV scaling relationship, which has significant scatter

and has been criticized on several fronts. We have developed an approach to significantly reduce the uncertainty of C IV based masses that rests on a better understanding of a major source of scatter, and have also identified a significant bias in previously published C IV scaling relationships, such that masses are about 50 percent too small on average. Using a combination of HST and ground-based data, we propose to further develop and publish both an average correction to C IV-based masses as well as a new correction term, based on easy and robust spectral measurements, resulting in greatly improved masses. We will also produce a mass estimator based on Lyman alpha, convenient for the highest redshift quasars. Finally,
we will test the new formulations against high-redshift, high-luminosity quasars with Lyman alpha, C IV, and Hbeta spectra available, using consistent measurement techniques and make luminosity dependent corrections as needed. As a byproduct, we will produce a catalog of consistent measurements of HST-observed UV quasar spectra along with ground-based optical spectra.

Proposal Category:	AR
Scientific Category:	Cosmology
ID:	13238
Program Title:	Resolving Galaxy Cluster Substructure with Gravitational Lensing Flexion
Principal Investigator:	Benjamin Cain
PI Institution:	University of California - Davis

While it is well established that clusters of galaxies reside in dark matter haloes, simulations lead us to believe that there is substantial residual dark matter substructure in those halos. Weak gravitational lensing is well suited to to studying the large scale properties of these halos but less so for studying substructure. Gravitational lensing flexion, the next-higher order lensing effect after shear, is extremely well-suited to measuring substructure, both because it acts at shorter range and because fewer background objects are needed to get a significant signal. We propose to apply a gravitational lensing analysis and mass reconstruction particularly suited to detecting substructure to a sample of 20 massive galaxy clusters, complementing strong lensing and weak lensing measurements with flexion in the mass reconstructions. Because flexion is a sensitive probe of mass gradients, we will detect structure on smaller spatial scales than are accessible to shear analyses, and will do so over a larger area than is possible with strong lensing analyses alone. Our strong+weak+flexion lensing approach will make a census of substructures down to M~3x10^12 solar masses over an entire HST/ACS field of view. Using our detailed mapping of the cluster mass distributions we will measure the normalization of the subhalo mass function (which is equivalent to the substructure mass fraction) to 10% error, and place an empirical constraint on its slope as well.

Proposal Category:	AR
Scientific Category:	ISM in External Galaxies
ID:	13239
Program Title:	An Archival COS Study of Multi-phase Galactic Outflows and Their Dependence on Host Galaxy Properties
Principal Investigator:	John Chisholm

PI Institution: University of Wisconsin - Madison

Galactic outflows have become vital for understanding galaxy evolution. Outflows have been used to explain the mass-metallicity relation, the star formation history of the universe, and the shape of the baryonic mass function. However, few studies have focused on the basic question of how outflow velocities depend upon the physical properties of their host galaxies. Here we propose an archival project utilizing 52 COS spectra of local star-forming galaxies spanning four decades of star formation rate, and stellar mass. We will preform a self-consistent analysis of trends between galactic properties (star formation rate, stellar mass, specific star formation rate and star formation rate surface density) and outflow velocities measured from interstellar metal absorption lines (e.g., CII 1335). We will extend this analysis to different gas phases -- cold, warm, and hot -- to gain a more comprehensive understanding of the physics of multi-phase outflows. The trends we observe will provide insights into the feedback process and will be crucial new benchmarks for simulations.

Proposal Category: AR

Scientific Category: AGN QUASARS

ID: 13240

Program Title: A dedicated search for Gravitational Wave recoiling supermassive black holes in COSMOS

Principal Investigator: Francesca Civano

PI Institution: Dartmouth College

During the coalescence of a supermassive black hole (SMBH) binary in a major galaxy merger, the asymmetric emission

of gravitational waves can displace the newly merged SMBH from the host center, significantly affecting the SMBH-galaxy co-evolution. The kick velocity may be significantly higher than the escape velocity of the galaxy (up to 5000 km/s),
but for realistic spin and mass ratio distributions, most recoil velocities should be lower.
If the recoil kick is large enough to substantially displace/eject the SMBH from the galaxy center,
it may be observable as an offset active SMBH, before its fuel is exhausted.

While extensive simulations have been performed, only 7 candidate recoiling SMBHs have been discovered so far. We propose to perform the first systematic search for spatially-offset (with v<~v_esc) recoiling SMBHs using COSMOS, the

largest contiguous HST/ACS imaging survey ever taken with high spatial resolution data (0.03"/pixel).
According to model predictions, we expect to find at least 1 (up to several tens) recoiling SMBHs. Any number of detections, including zero, will be promptly compared and used to tune models and simulations, and will help to constrain the SMBH merger rates.

We will select candidates by using accurate 2D fitting imaging analysis on a sample of ~50,000 COSMOS galaxies (z<1 and F814W(AB)<24). We will isolate sources with disturbed

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Proposal Category: AR

Scientific Category: Resolved Stellar Populations

ID: 13241

Program Title: Using Resolved Stellar Populations To Tune The Pixel-by-pixel SED Fitting Technique

Principal Investigator: Seth Cohen

PI Institution: Arizona State University

With the superb imaging capability of HST, we can see the detailed features of the current state of star formation and evolution in nearby galaxies, where their stars and star clusters are often resolved into individual stars. For galaxies at higher redshift (0.5<z<1.5), the best we can do is to study their integrated flux by spectroscopy or the SED fitting technique. With sub-arcsecond HST imaging, the broad-band SEDs of intermediate redshift galaxies can be fit on a pixel-by-pixel (pSED) basis. Due to the difference in the physical spatial resolution in images of galaxies at low and intermediate redshifts, blending of stellar populations makes the interpretation of the pSED analysis difficult, and these effects need to be studied in further detail.

Therefore, we propose to assess the resolution limit of the pSED fitting technique for intermediate redshift galaxies, and study the effects of stellar population mixing. We will compare properties (e.g., stellar mass, age, star-formation rate, metallicity) of the resolved stellar populations in nearby galaxies (<12 Mpc) to those of unresolved stellar populations in galaxies at intermediate redshift (0.5<z<1.5). With a carefully selected sample of galaxies at low and intermediate redshifts, we will

1) Perform a resolved stellar population study on six nearby galaxies from the Archive.
2) Apply the pSED method to artificially redshifted versions of these galaxies.
3) Quantify the size-scale where the pSED technique breaks down by relating the results of (1) and (2)
4) Use this result to better interpret the pSED fits on a sample of >100 intermediate redshift galaxies from CANDELS-GOODS Archival data.

Proposal Category: AR

Scientific Category: Unresolved Stellar Populations

ID: 13242

Program Title: The Role of Environment in the Growth of Compact Ellipticals

Principal Investigator: Michael Cooper

PI Institution: University of California - Irvine

A variety of observations now indicate that the progenitors of today's massive early-type galaxies were very compact at z ~ 2, suggesting that they must have undergone significant size growth over the past 10 Gyr. Studies of galaxy environment offer a unique probe of the physical mechanisms driving this size evolution, allowing us to distinguish the effects of environment-dependent processes (such as mergers) from those of secular processes. Here, we propose a comprehensive analysis of the HST imaging data from multiple large programs, including the new Frontier Fields initiative, with the ultimate goals of [1] measuring the minor-merger rate as a function of environment at z ~ 0.5 and [2] constraining the size-density relation across a broad range of overdensity, from isolated field galaxies to the centers of rich clusters. Through comparison with simulations, we will determine whether minor mergers are sufficient to explain the observed size evolution as a function of environment.

In addition to valuable constraints on the physical mechanisms driving size growth at z < 2, our analysis will yield a wealth of legacy data products, including quantitative morphology and size measurements, photometric redshift and stellar mass catalogs, as well as environment statistics across multiple legacy HST fields.

Proposal Category: AR
Scientific Category: Resolved Stellar Populations
ID: 13243
Program Title: Masses or mass constraints for 116 gravitational microlenses from archived HST images

Principal Investigator: Rosanne Di Stefano
PI Institution: Smithsonian Institution Astrophysical Observatory

Approximately 12,000 gravitational microlensing events have been discovered through ground-based monitoring. Although observations of gravitational lensing events have the potential to provide measurements of the mass of the lens, only a handful of mass measurements have actually been made. If the lens-source pair can be resolved in images taken years prior to or after the event, and if the distance to the lens can be estimated, then information derived from the event light curve can be employed to measure the lens mass, an approach first attempted and verified through HST observations of the field containing the MACHO-LMC-5 event. We propose the first systematic mining of hundreds of HST images taken of the fields containing 116 recorded microlensing events. In each case, we will either derive the gravitational mass of the lens, or else place meaningful limits on a combination of its mass and distance from us.

Proposal Category: AR
Scientific Category: Cosmology
ID: 13244
Program Title: Galactic Outflows and the Growth of Disks at 1<z<2

Principal Investigator: Dawn Erb
PI Institution: University of Wisconsin - Milwaukee

Galaxy-scale outflows of gas driven by intense star formation are one of the primary drivers of galactic evolution. These outflows undoubtedly depend on the properties of the galaxies involved; both observations of local systems and theoretical models indicate scalings with mass, star formation rate, and the surface density of star formation, though the details of these relationships are not yet clear. The geometry of galactic outflows also depends on galaxy structure: in the local universe, outflows are observed to be collimated perpendicular to galactic disks, and evidence for such collimation is observed at redshifts up to z~1. In contrast, the ubiquitous outflows seen in galaxies at z~2 appear to be roughly spherical, with no significant dependence on inclination. The apparent increase in the collimation of outflows over the redshift range 1<z<2 coincides with the growth of disks and the development of the Hubble sequence.

We propose a combined morphological and spectroscopic analysis of galaxies at 1<z<2, the epoch of disk growth and increased collimation of outflows. Using archival HST ACS imaging and Keck/DEIMOS spectra of absorption and emission lines tracing outflowing gas, we will measure galaxy sizes, star formation rate surface densities, axis ratios and other morphological parameters, and assess correlations between these quantities and spectroscopic diagnostics of outflows. The combined power of HST-based morphological measurements and deep spectra will shed light on the relationship

between galactic outflows and galaxy structure, during a key period in the history of galaxy growth.

Proposal Category: AR
Scientific Category: Quasar Absorption Lines
ID: 13245
Program Title: Reading the message in the light: understanding STIS and COS spectra, preparing for the Webb Era

Principal Investigator: Gary Ferland
PI Institution: University of Kentucky

UV spectroscopy reveals the chemical composition, star formation history, kinematic state, and excitation conditions of a vast variety of astronomical objects. The gas producing the spectrum is usually far from equilibrium and its properties set by a host of microphysical processes. I developed the plasma simulation code Cloudy to model just such environments. The code is widely used across the astronomical community, with nearly 200 papers citing its documentation each year, many of these studies involving HST observations.

I request support for continued development of Cloudy with an emphasis on low-ionization regions detected in absorption in the UV, and in emission in the UV through IR. This complements my previous Theory grant, now ending, which developed a framework for using large atomic databases and creating models of high-ionization species. The proposed new work has several parts: A) the incorporation of recently developed theories for the formation of molecular hydrogen on grain surfaces, B) the expansion of the atomic database to low-ionization species, complementing the previous work, and C) upgrade the low-ionization atomic and molecular emission models.

These more robust simulations of lower-ionization species formed near atomic / molecular transition regions have obvious implications for observations of intergalactic or associated absorbers. The atoms which absorb in the UV also emit in the optical / IR. Cloudy does a full simulation of the microphysics of the gas and dust, so the IR emission is also predicted. The work proposed here, while focusing on the UV, will, as a no-cost spinoff, improve emission models for wavelengths detected by Webb.

Proposal Category: AR
Scientific Category: Cool Stars
ID: 13246
Program Title: The nucleosynthetic origins and chemical evolution of phosphorus in the early universe

Principal Investigator: Anna Frebel
PI Institution: Massachusetts Institute of Technology

Relatively little is known about the chemical evolution of the element phosphorus, despite its relatively large abundance in the Sun and its importance for biological life. The goal of this archive proposal is to establish the chemical evolution trend of phosphorus, extending our knowledge from solar metallicity to stars with less than 1/1000th the solar metallicity.

Previous studies have used weak near-infrared P I lines to establish phosphorus abundance trends from -1.0 < [Fe/H] < 0. We have identified a strong P I doublet in the UV at 2136 Angstroms, which is present in the spectra of 22 stars available in the HST archives. Our study will (1) improve on the limited observations of the abundance trend at high metallicity and extend it to metallicities lower by ~2 dex and (2) determine whether [P/Fe] flattens out towards lower

metallicities (like the alpha-elements Mg, Si, Ca, and Ti) or whether it continues to increase (like Co and Zn). Our results will provide the first tight constraints on the nucleosynthesis of phosphorus and its production sites in the early Universe.

We request one semester of funding to support a graduate student to lead the spectral analysis work, one month of summer salary, and miscellaneous travel and publication costs.

Proposal Category: AR
Scientific Category: Solar System
ID: 13247
Program Title: deep Field TNO colors with in Archival Frontier Fields

Principal Investigator: Cesar Fuentes
PI Institution: Northern Arizona University

We propose an archival project to use the Frontier Fields observations in Cycle 21 to measure the color distribution of dynamically hot TNOs smaller than the break in the TNO size distribution (R>25). By coadding the light from each two-orbit visit and accounting for the motion of the TNOs we will detect and measure statistically the colors of 10-50 very faint TNOs- of which there are none with known colors. By comparing the color distribution of objects larger and smaller and the break we will test whether the break in the size distribution of hot objects is collisional, and if the bluer colors of this population are primordial.

Proposal Category: AR
Scientific Category: AGN QUASARS
ID: 13248
Program Title: AGN Fueling: Alignments Between Circumnuclear Structures and Radio Jets?

Principal Investigator: Jenny Greene
PI Institution: Princeton University

Evidence is mounting that moderate luminosity active galaxies at all redshifts are found in undisturbed disk galaxies, and yet we still have very limited understanding of how secular processes (such as bars) facilitate accretion. We propose to study the relationship between the angular momentum of gas on ~100-pc scales and the sub-pc scale disk using archival HST imaging of local Seyfert galaxies with radio jets. We will uncover the statistical relationship between

the orientation of the sub-pc scale accretion disk with circumnuclear structures (rings, bars, and/or disks) identified with the HST imaging to reveal the interplay between secular bulge growth and nuclear activity.

Proposal Category:	AR
Scientific Category:	Resolved Stellar Populations
ID:	13249
Program Title:	Calibrating the Luminosity of Carbon Stars: An Archival Study of Galaxies in the Nearby Universe
Principal Investigator:	Aaron Grocholski
PI Institution:	Louisiana State University and A & M College

Intermediate age stellar populations dominate the light from high-redshift galaxies. Many of the stars in this age range end their lives as carbon-rich asymptotic giant branch stars (carbon stars), a luminous but poorly constrained stage of stellar evolution. Population synthesis codes currently depend on models of carbon star evolution, which have been calibrated over a limited range of parameters. Carbon stars may account for up to 40% of the bolometric luminosity in high-redshift galaxies and recent studies have shown that the uncertainty in the contribution of carbon stars to integrated galaxy light can cause galactic mass and age estimates to change by a factor of 2. Here we propose to significantly improve this calibration over a much larger range of galactic environments by performing an archival HST study of the resolved carbon star populations throughout the nearby Universe (within ~4 Mpc). Carbon stars are relatively easily identified in color-magnitude diagrams, allowing us to determine their luminosity and relative number densities. We have identified a sample of 40 galaxies with sufficiently deep HST photometry to determine accurate star formation histories and compare the properties of the carbon stars to the properties (e.g., age, metallicity, star formation rate) of the underlying populations. Our study will result in an empirical calibration of carbon stars that can be used to place much needed constraints on stellar evolution models and thereby improve our understanding of galaxy evolution.

Proposal Category:	AR
Scientific Category:	Resolved Stellar Populations
ID:	13250
Program Title:	Probabilistic Self-Calibration of the WFC3 IR Channel
Principal Investigator:	David Hogg

PI Institution: New York University

The scientific output of any instrument hinges upon the quality of its calibration. Modern astronomical experiments rely on their instruments to be extremely precisely calibrated; these demands will only increase in upcoming missions, along with demands to reduce calibration overheads. This proposal is to explore new kinds of calibration methods that make use of science data (rather than specifically designed calibration data). We propose to develop a new form of probabilistic self-calibration and apply it to all of the science data taken with the WFC3 IR instrument through the F110W and F160W filters. Our method relies on the fact that in the full corpus of MAST, many similar kinds of astronomical sources (like stars) touch every part of the detector. We can therefore construct a probabilistic model for the entire imaging data set, deviations from which are plausibly described as calibration errors. The method also relies on sensible priors from existing calibration information and astronomical knowledge. Our project will deliver a new, pixel-to-pixel flat field for the two filters, verifying the existing flat (which is based on pre-launch data), and potentially improving the current calibration. After achieving the baseline goals we will explore higher-order issues like persistence and time variations in sensitivity.

Proposal Category: AR

Scientific Category: ISM and Circumstellar Matter

ID: 13251

Program Title: DISKSPEC: A Tool for Analyzing Observed Spectra of Accretion Disk Systems

Principal Investigator: Ivan Hubeny

PI Institution: University of Arizona

Accretion disks are ubiquitous in astronomy, associated with AGN, stellar mass black holes, X-ray binaries, progenitors of Ia supernovae, X-ray binaries, cataclysmic variables (CVs) (ordinary, recurrent, and dwarf novae, novalikes), pre-main sequence stars. An understanding of the nature of, and physical processes in, accretion disks is one of the central themes in astrophysics. A large number of past, present, and future HST observational programs were/are/will be devoted to astronomical systems that harbor an accretion disk.

We propose to develop a package DISKSPEC, which enables the user to generate a synthetic spectum of an accretion disk for essentially any combination of input parameters. The strategy is to use a sufficiently dense and extended grid of models for generic
disk rings, and to develop a code that computes a spectrum of the whole disk by interpolating the generic grid spectra to the actual spectra emergent from the individual radial rings of the disk, and integrates over the disk taking into account Doppler shifts due to disk rotation.

We believe that the package will serve many researchers using new or archival HST data to be able to perform a spectroscopic analysis of objects that contain an accretion disk in a fast and flexible way, and thus contribute significantly to a better use of past, present, and future HST observations.

Proposal Category: AR

Scientific Category: Cosmology

ID: 13252

Program Title: High level science products from deep ACS and WFC3/IR imaging over the CDF-S/GOODS-S region

Principal Investigator: Garth Illingworth

PI Institution: University of California - Santa Cruz

The CDF-S, with its extensive datasets that include the well-known HUDF, GOODS and CANDELS fields, is a remarkable resource for studying distant galaxies. CDF-S is a unique region in the sky. An astonishing 6 Msec of Hubble data (nearly 2600 orbits of WFC3 and ACS data alone), 6 Msec of Spitzer IRAC images, and 4 Msec of Chandra data, plus ground-based spectra, imaging and, now, ALMA observations, make this one of Hubble's key legacy areas. Remarkably, while the major areas, HUDF, GOODS and CANDELS are available as high-level data products, over 40% (~1000 orbits) of HST data are unavailable to the community as high-level science products and catalogs in MAST. This includes several deep fields, including the parallel field HUDF09-2 which reaches as deep in ACS (~400 orbits) as the HUDF. We propose to use our extensive experience processing and delivering HST ACS and WFC3/IR datasets to STScI MAST to now deliver a complete processed and aligned dataset of all deep fields and the deeper, but as-yet-unused, SNe follow-up and parallel datasets across the CDF-S. The same will be done for the much smaller but similar dataset on the HDF-N region. These data products will add substantially to our understanding of the build up of galaxies to z~6 in the first Gyr during reionization, and their impact on reionization, the development of galaxies over the subsequent Gyr to to the peak of the star formation rate in the universe around 2-3 Gyr after the Big Bang at z~2-3, and the transition of early star-forming galaxies to the full splendor of the Hubble sequence since z~2. These Hubble Legacy Field datasets will be of great value as the Frontier Fields are used by the community.

Proposal Category: AR

Scientific Category: ISM and Circumstellar Matter

ID: 13253

Program Title: Filling in the Gaps in a Study of Gas that Molds the Fermi Bubbles: An Archival Supplement to a Cycle 20 GO Program

Principal Investigator: Edward Jenkins

PI Institution: Princeton University

Two sharply defined lobes of gamma-ray emission emerging from the center of our Galaxy, called the Fermi Bubbles, have been discovered in the Galactic halo. Their emissivity appears to be uniform and extends up to 8 kpc on either side of the plane. Accompanying the Fermi Bubbles are excess emissions seen in X-rays, microwaves and polarized, low frequency radio emissions. It is generally believed that cosmic ray particles emitted from the central portion of the Galactic disk (or perhaps the nucleus itself) are responsible for these emissions. These particles must have been advected into the halo by a wind or shock. Our COS observations of 5 extragalactic targets behind or near the southern lobe of the Fermi Bubbles will help us to understand the physical nature and kinematics of the gas responsible for this transport. Spectra in the MAST archive for other extragalactic targets in the same part of the sky, plus those of some foreground stars, should offer us further guidance in our interpretation of the primary data obtained from the Cycle 20 observations.

Proposal Category: AR
Scientific Category: ISM and Circumstellar Matter
ID: 13254
Program Title: A New Look at Interstellar Silicon

Principal Investigator: Adam Jensen

PI Institution: Wesleyan University

Silicon is a relatively abundant metal that is critical in interstellar chemistry. However, there are significant questions about its gas- and dust-phase abundances in the interstellar medium (ISM). We will use a method of stellar modeling and absorption line analysis that has recently been demonstrated to precisely determine gas-phase column densities (of carbon) even using saturated lines. We have identified 39 targets (using 107 datasets) that will allow us to carry out this analysis. This will allow us to more precisely determine the poorly known Si II gas-phase abundance in lines of sight with A_V>1 magnitude and see how the Si gas-phase abundance depends on physical properties of the line of sight. With this large sample we will specifically test a hypothesis about the role of silicon in small interstellar dust grains, and complete a survey of the six most abundant metals dust-relevant metals (C, N, O, Mg, Si, and Fe) in lines of sight with A_V>1. Our proposed analysis represents an upgrade over previous studies in the following ways: (1) we will use high S/N, high-resolution STIS UV spectra, a major improvement over older Copernicus and IUE studies; (2) we will use more than seven times the number of interstellar lines of sight with measured abundances and complete extinction parameters than the only comparable STIS survey of Si II in the ISM; and (3) we will use detailed stellar modeling and all available Si II absorption lines in order to reduce systematic and statistical uncertainties, compared to studies based on only the weak line at 2335.12 Angstroms (which is typically used to study Si II and has a much less certain f-value).

Proposal Category: AR
Scientific Category: Unresolved Stellar Populations
ID: 13255
Program Title: Galaxy evolution in the densest environments: HST imaging

Principal Investigator: Inger Jorgensen

PI Institution: Gemini Observatory, Northern Operations

We propose to process in a consistent fashion all available HST/ACS and WFC3 imaging of seven rich clusters of galaxies at z=1.2-1.6. The clusters are part of our larger project aimed at constraining models for galaxy evolution in dense environments from observations of stellar populations in rich z=1.2-2 galaxy clusters. The main objective is to establish the star formation (SF) history and structural evolution over this epoch during which large changes in SF rates and galaxy structure are expected to take place in cluster galaxies.

The observational data required to meet our main objective are deep HST imaging and high S/N spectroscopy of individual cluster members. The HST imaging already exists for the seven rich clusters at z=1.2-1.6 included in this archive proposal. However, the data have not been consistently processed to derive colors, magnitudes, sizes and morphological parameters for all potential cluster members bright enough to be suitable for spectroscopic observations with 8-m class telescopes. We propose to carry out this processing and make all derived parameters publicly available.

We will use the parameters derived from the HST imaging to (1) study the structural evolution of the galaxies, (2) select clusters and galaxies for spectroscopic observations, and (3) use the photometry and spectroscopy together for

a unified analysis aimed at the SF history and structural changes. The analysis will also utilize data from the Gemini/HST Cluster Galaxy Project, which covers rich clusters at z=0.2-1.0 and for which we have similar HST imaging and high S/N spectroscopy available.

Proposal Category: AR
Scientific Category: Unresolved Star Formation
ID: 13256
Program Title: Tools for Stellar Population Synthesis in the Stochastic Regime

Principal Investigator: Mark Krumholz
PI Institution: University of California - Santa Cruz

HST has allowed us to observe both nearby and distant galaxies with unprecedented resolution and sensitivity, enabling us to probe to ever-smaller spatial scales, masses, and star formation rates. However, many of the stellar population synthesis (SPS) models we use to extract physical quantities from these observations do not properly account for the stochastic effects that become important when we cannot assume that an observed stellar population adequately samples all possible stellar masses and evolutionary stages. In this regime, stochastic sampling introduces fundamental and, at present, largely uncalibrated limitations on the information that can be gleaned from unresolved photometry. Last year we introduced a new code, Stochastically Lighitng Up Galaxies (SLUG), for SPS in the stochastic regime. We now propose to expand SLUG's capabilties to make it an even more powerful tool for analyzing HST data. We will use SLUG models to characterize the amount of stochastic scatter in various filters expected as a result of stochasticity, and the corresponding uncertainty this induces in estimates of various parameters (e.g. star formation rates, cluster masses, dust extinctions). We will provide software tools to calculate probability distributions for these parameters from observations in a variety of filters. We will also couple SLUG to the photoionization code CLOUDY, enabling for the first time a proper stochastic treatment of nebular line emission as well. The resulting code will be released to the community, facilitating greater understanding of the uncertainties in past, present, and future HST observations, and assisting observers in planning future campaigns.

Proposal Category: AR
Scientific Category: Debris Disks
ID: 13257
Program Title: SMACK: A New Tool for Modeling Images of Debris Disks

Principal Investigator: Marc Kuchner
PI Institution: NASA Goddard Space Flight Center

HST and JWST images of planetary signatures in debris disks can be important tools for finding hidden exoplanets and constraining their properties when the images are interpreted via numerical models. But current models can not yet model the time-dependent interplay between planetesimal collisions and dynamics. For example, they fail to accurately model patterns like the ubiquitous warps and eccentric rings, which are interactions between collisional and secular dynamical phenomena. We propose to develop a new numerical tool called "SMACK" that will model the locations of planetesimal collisions that release the dust in debris disks, the dynamical effects of these collisions, and the evolving planetesimal size-velocity distribution in 3D. We will apply this code to derive new constraints on the masses of planets orbiting Beta Pictoris and Fomalhaut, and to study the latest debris disk images from the GO 12228 STIS survey. SMACK will be made available to the community in the form of new modules for the popular, publically available

REBOUND code.

Proposal Category: AR
Scientific Category: Resolved Star Formation
ID: 13258
Program Title: Kinematics of the Massive Star Forming Region, Orion BN/KL

Principal Investigator: Jessica Lu

PI Institution: University of Hawaii

The dynamics of stars in the Orion Nebula Cluster (ONC) hold the clues to the history of this nearby region of massive star formation. We propose to investigate the stellar dynamics in the ONC with unprecedented depth and accuracy by carrying out an astrometric study of the proper motions of stars in this region, including the Trapezium Cluster and stars in and around the Kleinmann-Low Nebula (KL). Numerous images of the ONC have been taken by the HST between 1995 and 2007 at several wavelengths, so we will take advantage of this long time baseline and of the excellent astrometric properties of this rich data set to construct a new database of proper motions. This astrometric database will be used to tie together the radio, infrared and optical reference frames for the ONC, and to decide between dynamical hypotheses that have been offered for the radio and infrared- bright protostellar objects in the KL Nebula, including the Becklin-Neugebauer source, and the well-studied radio sources "I" and "n". We will also use the proper motion database to look for dynamical substructure and mass segregation in the ONC, as well as runaway stars and other repercussions of cataclysmic dynamical events. The proposing team has considerable experience with astrometric studies of massive clusters, as well as with research on the stellar and protostellar content of the Orion and KL Nebulae.

Proposal Category: AR
Scientific Category: Unresolved Stellar Populations
ID: 13259
Program Title: Combined Study of High Spatial Resolution Color and Mass Maps with Dynamics of Galaxies

Principal Investigator: Bahram Mobasher

PI Institution: University of California - Riverside

A picture of galaxy formation is emerging where clumpy, irregular systems undergo high rates of early accretion and merging,
leading to star formation activity, and subsequently settling into secularly evolving Hubble types at intermediate redshifts $0.2 < z < 1.0$. However, the specific details of this transition are not well understood. The aim of this archival

proposal is to uncover the nature of the transition from clumpy to disk-like systems by leveraging the high spatial resolution HST/ACS and WFC3 imaging for a sample of disk galaxies for which dynamical data from ground-based spectroscopy with the Keck Telescope already exist. We will use the deep HST/ACS and WFC3 data for 120 galaxies in the GOODS fields, with available high resolution spectroscopic data, to construct resolved stellar population, extinction, and stellar mass maps, to examine the small-scale distributions of dust, star formation, and mass clumps in these galaxies, and the relation of these properties to galaxy dynamics. A unique feature of this study is the availability of the high resolution imaging and dynamical data from the HST and Keck. This allows, for the first time, a detail study of the kpc-scale and integrated (global) properties of galaxies with spectroscopic characteristics (ie. dynamical mass).

Proposal Category:	AR
Scientific Category:	AGN QUASARS
ID:	13260
Program Title:	The Physics of the Coronal Line Region in Seyfert Galaxies and its Role in Galaxy Evolution
Principal Investigator:	Francisco Mueller-Sanchez
PI Institution:	University of California - Los Angeles

We propose an archival program to perform what will be the largest-ever study of the kinematics of the optical high ionization (or coronal) lines in nearby Active Galactic Nuclei (AGN). The data, most of which were obtained serendipitously as part of several HST campaigns to study either the Halpha or [OIII] emission line profiles, give us high spatial resolution STIS observations of several coronal lines (such as [Ne V], [Fe VII] and [Fe X]) in more than fifty of the nearest AGNs. We will use these extraordinary datasets to: (i) measure the size and power of the Coronal Line Region (CLR), and trends with the AGN properties, (ii) determine the physical conditions (temperature and density) of the coronal gas from ratios of two coronal lines or a coronal line and a lower ionization line present in the spectrum (e. g. [Ne V]/[O III], [Fe X]/[O II], [Fe VII] 3760/ [Fe VII] 6087), (iii) analyze the velocity profiles and the radial velocity curves of [Fe VII], [Fe X] and [Ne V] to detect signatures of outflows in the high-ionization gas, and (iv) in the targets with clear outflow signatures, measure the mass and energy imparted by the AGN outflow into the interstellar medium.

Proposal Category:	AR
Scientific Category:	Quasar Absorption Lines
ID:	13261
Program Title:	Unlocking the secrets of absorption line complexes in the intergalactic medium
Principal Investigator:	Brian O'Shea

PI Institution: Michigan State University

It is well-established that the fraction of baryons in the Universe that are observable drops from nearly 100% at z ~ 3 to less than 50% by z ~ 0. Simulations predict that most of the missing baryons are located in the IGM at moderate densities and at temperatures of 10^5-10^7 K - gas that is generally in the filaments of the cosmic web and in circumgalactic regions. This gas is typically detected in the low-z Lyman alpha forest by measuring UV absorption lines of highly ionized metals, such as CIV and OVI. However, significant uncertainties exist relating to the physical conditions of the gas associated with these lines (such as temperature, metallicity, and ionization state), which severely limits our ability to understand the physical environment of these absorbers. We propose to clarify the relationship between the multi-species absorption line complexes seen in QSO spectra and the physical conditions of the corresponding absorbing gas. We will do this using synthetic observing tools and the largest, most detailed simulations of the IGM to date, which include a new sophisticated treatment of non-equilibrium gas chemistry. We will create catalogs that enable conversion between specific combinations of observed absorption lines and the equivalent physical gas distribition, will calculate the total baryon content that is traceable with each ion, and will devise tests to distinguish between the circumgalactic and truly intergalactic medium. This work will be critical to the interpretation of previous and ongoing HST studies of the IGM - particularly those using the Cosmic Origins Spectrograph - and directly addresses the HST Cycle 21 Ultraviolet Initiative.

Proposal Category: AR
Scientific Category: Quasar Absorption Lines
ID: 13262
Program Title: Cosmic HI: a tracer of the physics regulating galaxy formation over a Hubble time

Principal Investigator: Benjamin Oppenheimer

PI Institution: Universiteit Leiden

We propose a rigorous exploration of cosmic HI using state-of-the-art SPH simulations with advanced particle tracking capabilities to confront the rapidly expanding inventory of Lyman-limit system (LLS) and damped Lyman-alpha absorber (DLA) observations extending over a Hubble time. Unlike metals, hydrogen has the advantage of being a simple element understand that ubiquitously traces accretion (pristine and enriched), star formation, and outflows. We will address two main questions about cosmic HI: 1) Why do the number and mass density of DLAs stay nearly flat over 13 Gyrs of cosmic time, while star formation declines by a factor of 20?, and 2) Is the observed LLS metallicity bimodality an outcome of two distinct physical mechanisms driving galaxy formation? This project will use existing and new state-of-the-art simulations that match observed galaxy properties, process outputs identically to real observations, and distill the fundamental physical mechanisms regulating galaxy formation. Our assembled team includes theorists capable of running simulations and analyzing them, leading experts in the understanding of cosmic hydrogen, and an observer with access to and knowledge of the relevant COS data.

Proposal Category: AR
Scientific Category: Cool Stars
ID: 13263

Program Title: Determining Fe I Energy Levels with STIS 230H Near-UV Spectra of Metal-Poor Stars

Principal Investigator: Ruth Peterson

PI Institution: Astrophysical Advances

With rapid technological and computational advances in astrophysics, a multitude of ever fainter objects near and far are being observed with greater and greater precision. Seriously lacking are reliable, comprehensive atomic data needed to interpret the present and future wealth of information. The Fe I atom is a notable example: measurements of the energies of its high-lying levels are woefully incomplete.

Here we propose to determine upper energies of Fe I using STIS E230H archival spectra of metal-poor stars spanning 1850A - 3150A. Our spectral calculations match these well, except for lines of unknown identification. The vast majority are due to Fe I lines whose predicted wavelengths are in error because the upper energy level is not measured. We can derive the energy for a particular upper level by adopting a trial value providing a wavelength for one of its strong predicted near-UV lines that matches the wavelength of a strong unidentified spectral line, then checking the new wavelengths of other strong predicted transitions that share the same upper level for coincidence with other strong unidentified lines.

To date we have matched three or more transitions for eight levels, deriving energies up to 63183 cm^-1 (7.8 eV), and identifying 1228 individual lines. Our goal is to do this for 100 new levels, and to understand how best to extend this to levels with weaker transitions only. The newly-identified energy levels and resulting line parameters will be placed on the Kurucz website, to enable better use of Hubble archive products by the community, for research ranging from nucleosynthesis at early epochs to deriving age and metallicity for old, distant galaxies.

Proposal Category: AR

Scientific Category: Cosmology

ID: 13264

Program Title: The New Frontier of cosmological Simulations: Robust predictions of the galaxy population properties at z>4.

Principal Investigator: Thomas Quinn

PI Institution: University of Washington

To provide predictions for the galaxies to be observed with the HST New Frontier Fields we propose to run and analyze a set of cosmological simulations that focus on the assembly of the first population of low mass galaxies in a Lambda CDM Universe.

This research project will focus on achieving these specific goals:

1- Understand the physical processes driving the normalization and slope of the galaxy LF down to M_UV ~ -10 at 12 > z > 4 and provide the first prediction of the morphology of such objects.

2- Evaluate how assumptions on the metallicity and dust distribution of galaxies affect current estimates of the specific SFR and stellar masses of high-z galaxies obtained from high-z surveys.

Planned simulations will take advantage of a new version of our cosmological SPH code GASOLINE/CHaNGa that will include:

- A new SPH implementation that improves the treatment of Kelvin-Helmoltz

Proposal Category: AR
Scientific Category: Unresolved Stellar Populations
ID: 13265
Program Title: Simulating the Birth of Massive Star Clusters: Is Destruction Inevitable?

Principal Investigator: Anna Rosen
PI Institution: University of California - Santa Cruz

Very early in its operation, the Hubble Space Telescope (HST) opened an entirely new frontier: study of the demographics and properties of star clusters far beyond the Milky Way. However, interpretation of HST's observations has proven difficult, and has led to the development of two conflicting models. One view is that most massive star clusters are disrupted during their infancy by feedback from newly formed stars (i.e., "infant mortality"), independent of cluster mass or environment. The other model is that most star clusters survive their infancy and are disrupted later by mass-dependent dynamical processes. Since observations at present have failed to discriminate between these views, we propose a theoretical investigation to provide new insight. We will perform radiation-hydrodynamic simulations of the formation of massive star clusters, including for the first time a realistic treatment of the most important stellar feedback processes. These simulations will elucidate the physics of stellar feedback, and allow us to determine whether cluster disruption is mass-dependent or -independent. We will also use our simulations to search for observational diagnostics that can distinguish bound from unbound clusters, and to predict how cluster disruption affects the cluster luminosity function in a variety of galactic environments.

Proposal Category: AR
Scientific Category: Cool Stars
ID: 13266
Program Title: Understanding the Population of Distant Ultracool-Dwarfs from WISPS and 3d-HST

Principal Investigator: Russell Ryan
PI Institution: Space Telescope Science Institute

We are the proposing largest, most comprehensive archival campaign with HST to identify and characterize distant brown dwarfs to date. By exploiting the unprecedented sensitivity and excellent field-of-view of the WFC3/IR detector, we expect to find ~110 M- and ~30 L-dwarfs out to heliocentric distances of >1000 pc (for an L8-dwarf), whereas current surveys are limited to <300 pc. Furthermore, by observing with an infrared grism that optimally samples the water absorption feature at 1.4 microns, we can easily distinguish our target sample from interloping objects. Therefore our sample will be >90% complete to J~24 and nearly 100% free of contaminating objects (such as giants, subdwarfs, or high-redshift quasars). We have four main science goals for these ultracool dwarfs:

(1) Identify ultracool dwarfs from water absorption;

(2) Measure the vertical scale height as a function of spectral type;

(3) Characterize the atmospheric properties of distant ultracool-dwarfs; and

(4) Search for rare T/Y transition dwarfs by complete water/methane and enhanced ammonia absorption.

We plan to mine 0.5 square degrees of archival grism data in G141 taken by the pure-parallel (WISPS) and the Legacy (3d-HST) surveys. Our approach represents the most efficient means of surveying these low luminosity objects at kiloparsec distances with robust spectral types.

Proposal Category: AR
Scientific Category: Debris Disks
ID: 13267
Program Title: Reconstructing Lyman Alpha Radiation in T Tauri Stars

Principal Investigator: Eric Schindhelm
PI Institution: Southwest Research Institute

We propose to analyze archival HST-COS/STIS data with new spectral modeling techniques to determine the UV radiation field and molecular gas properties of the inner regions of low-mass protoplanetary disks (PPDs). HST-COS/STIS observations show in unprecedented detail a population of Lyman Alpha (LyA) photo-excited molecular gas in the inner disk (r < 10 AU), where the UV radiation field plays a strong role in gas abundances and planetary formation. While the LyA emission is scattered by interstellar and circumstellar material along the line of sight to most targets, the fluoresced CO and H2 emission lines are prevalent. We will simultaneously reconstruct the incident LyA radiation and determine the physical and dynamical properties of the fluorescing gas in a large sample (~40) of PPDs. Initial studies of some of these targets suggest a CO/H2 abundance ratio 3 to 4 orders of magnitude larger than expected from interstellar abundances, which would have direct bearing on the inferred gas mass available for planet-formation. However, this inference is based on different modeling techniques and different data sets from a very small number of objects. With the proposed large sample, a systematic approach will mitigate uncertainties related to time-variability and different model approaches, enabling accurate determination of relative abundances. We will also use the model LyA profiles and gas properties to determine extinctions towards each target. This AR proposal is submitted in parallel with a GO proposal to observe PPDs in the Orion Nebular Cluster, applying this same analysis to PPDs under external illumination from strong O and B star UV radiation fields.

Proposal Category: AR
Scientific Category: Unresolved Stellar Populations
ID: 13268
Program Title: The Structure of the Nearest Nuclear Star Clusters

Principal Investigator: Anil Seth
PI Institution: University of Utah

HST surveys have shown that nuclear star clusters are nearly ubiquitous in nearby galaxies with masses similar to or lower than the Milky Way. Like in the Milky Way they can coincide with black holes at the centers of galaxies. But, the overall "occupation fraction" of black holes within nuclear clusters is largely unconstrained. Measurements of the structure, stellar content, and mass profile of nuclear star clusters enable us to predict the rate of luminous tidal disruption events in lower mass galaxies and quantify the demographics of black holes in these galaxies for the first time.

We propose to analyze an extensive archive of observations of 80 nearby galaxy nuclei (D < 10 Mpc) to determine the

stellar density profiles and morphology of a large number of nuclear star clusters. These mass profiles will enable us to create the first robust predictions for the rate of luminous stellar tidal disruption events in lower mass galaxies. By combining these predictions with observed tidal disruption event rates from on-going and upcoming time-domain surveys, we will be able to constrain the occupation fractions of black holes in lower mass galaxies. The stellar mass profiles will also be used to derive total stellar masses for NSCs to test galaxy-nucleus scaling relationships. Furthermore, by analyzing the morphology and color-maps of our nuclear star clusters, we will examine how mass accretes into the nuclei over a wide range of masses and across Hubble type.

Proposal Category: AR
Scientific Category: Hot Stars
ID: 13269
Program Title: A Multiwavelength Study of Recurrent Novae in the Bulge of M31

Principal Investigator: Allen Shafter
PI Institution: San Diego State University

We propose a deep, multiwavelength, archival study of recurrent novae (RNe) in the bulge of M31. RNe, which are candidate progenitors of Type Ia SNe, are believed to be powered by massive white dwarfs with high accretion rates. They often have evolved secondaries, including red giant branch stars. We will study RNe in quiescence by analyzing the UV, optical, and IR counterparts of X-ray identified supersoft sources in the Panchromatic Hubble Andromeda Treasury survey and other archival data sets. This study will more than double the sample of confirmed RNe known to date. We will use this data set to investigate whether the unexpectedly high luminosity-specific nova rate in the older stellar populations of bulges and ellipticals can be explained by an excess of RNe that have so far not been recognized in the overall nova sample. In addition, we will investigate the variability of the quiescent counterparts of RNe at all available timescales and wavelengths. We will also study the link between the quiescent and outburst properties of RNe and its implications for the formation and evolution of novae. Finally, we will investigate whether RNe are preferentially found in metal rich populations, and its implications on models of binary formation and evolution. Low mass X-ray binaries, which are accreting neutron star systems, reveal a strong metallicity effect. Some theoretical models predict that such a metallicity effect should be apparent in other classes of compact binaries, such as RNe.

Proposal Category: AR
Scientific Category: Cosmology
ID: 13270
Program Title: Constraining the Physics of Dwarf Galaxy Formation from the Reionization Epoch to the Present

Principal Investigator: Rachel Somerville
PI Institution: Rutgers the State University of New Jersey

Recent observations with Hubble have allowed us to directly observe galaxies forming during the "reionization epoch", z~6-10. In some sense, the HST high-z observations have outpaced theory. In order to understand the constraints that the observations place on physical processes, we need to (a) ensure that the cosmological models that are used to

interpret HST data incorporate the most recent advances in our understanding of galaxy-scale physics and (b) apply the latest statistical techniques for translating theoretical predictions into the plane of the HST observations and rigorously assessing their successes and failures. The efficiency of galaxy formation in low-mass halos is sensitive to a complex network of intertwined processes, including star formation, chemical evolution, stellar-driven winds, and photo-ionization. We propose to update our semi-analytic models (SAM) with more physical recipes for star formation, improved treatment of stellar-driven outflows, and a self-consistent and spatially dependent treatment of reionization and photo-ionization. We will use high-resolution numerical hydrodynamic simulations with radiative transfer to guide our implementation of these new recipes, and test and calibrate our SAMs. We will then couple the SAM with Bayesian inference and advanced Markov Chain Monte Carlo techniques in order to determine how each of these physical processes impacts galaxy properties and quantify parameter degeneracies. We will use our improved models to create mock catalogs that will be made available to the community, and will be designed to enable direct contact with the HST Frontier Fields and future observations with JWST.

Proposal Category:	AR
Scientific Category:	Cosmology
ID:	13271
Program Title:	The cosmic evolution of faint satellites galaxies as a test of galaxy formation and the nature of dark matter
Principal Investigator:	Tommaso Treu
PI Institution:	University of California - Santa Barbara

We will measure the luminosity function and colors of ~10,000 satellites up to 10,000 times fainter than their hosts, and their evolution over cosmic time ($0.1<z<1.4$), by applying well-tested image processing and statistical tools to public datasets in the CANDELS fields. This unprecedented measurement will allow us to conduct a new test of galaxy formation models and the nature of dark matter, breaking degeneracies in the interpretation of local measurents of the satellite luminosity function. Semi-analytic models applied to cosmological simulations have been shown to reproduce the low redshift luminosity function of Milky Way satellites by combining differing strengths of supernovae and AGN feedback, stellar winds, UV heating during reionization, ram-pressure stripping and tidal torques exerted by the host halos. Alternatively, the local luminosity function of satellites can also be matched by warm dark matter models. However, different CDM and WDM models make clear and distinctly varying predictions for the dependency of the colors and luminosity function of satellite galaxies over varying redshift and host stellar mass intervals (Nierenberg et al. 2013), which we will conclusively test with our analysis.

Proposal Category:	AR
Scientific Category:	Resolved Stellar Populations
ID:	13272
Program Title:	Proper Motions of Distant Halo Stars: New Clues to Milky Way Structure, Evolution and Mass
Principal Investigator:	Roeland van der Marel

PI Institution: Space Telescope Science Institute

The Milky Way (MW) is shrouded in a faint metal-poor stellar halo. Its structure and kinematics provide a unique archaeological record of the MW's formation, past evolution, and accretion history, and they also constrain the total dark matter mass out to large radii. The stellar density profile and radial velocity dispersion profile of the halo are known, but our understanding of the halo is limited by a striking lack of knowledge about the transverse motions of its stars. It is difficult from the ground to determine proper motions (PMs) far outside of the solar neighborhood. We have recently developed techniques for PM measurements from multi-epoch HST data using distant background galaxies as absolute reference frame. These techniques can be used to identify and measure PMs of distant halo stars in random fields: from the 3 fields observed in our widely-publicized Andromeda galaxy PM program, we managed to isolate 13 halo stars located at about 25 kpc. Their PMs imply a radial gradient in the halo velocity ellipsoid that suggests we are looking through a shell created by a past accretion event (NASA/STScI press release 2013-07). We propose to analyze another 142 fields that have deep multi-epoch data in the HST Archive for which we can perform similar PM measurements. We will create Legacy catalogs, and will extract PMs for ~710 distant MW halo stars (incl. 100 beyond 50 kpc). This will yield a spectacular improvement in our understanding of the halo, and of the structure, past evolution and mass of the MW. The proposed program is a prime example of how the HST Archive can be used after 23 years on orbit to tackle totally new forefront science.

Proposal Category: AR

Scientific Category: Resolved Stellar Populations

ID: 13273

Program Title: Effects of dynamical evolution on the stellar mass function of multiple population globular clusters

Principal Investigator: Enrico Vesperini

PI Institution: Indiana University System

Many observational studies have shown that globular clusters (GCs) host multiple stellar populations, challenging the standard view of GC formation, in which GCs are `simple stellar populations' composed of stars of uniform age and chemical composition.
Theoretical models of multiple-population GC formation predict that second-generation (SG) stars form in a compact subsystem embedded in a more extended first-generation (FG) cluster. Observational studies have found that in several GCs SG stars are indeed more concentrated in the cluster inner regions and still retain memory of the initial segregation predicted by theoretical models. We propose to study the effects of dynamical evolution on the stellar mass function (MF) in multiple-population GCs. No study has previously addressed this problem in this context, taking into account the structural properties predicted by models of formation and evolution of multiple-population GCs and exploring the evolution of the SG and FG MFs. We will study the evolution of the total MF of the cluster as well as the individual MFs of the FG and SG populations. We will address a series of questions concerning the evolution of both the global MF and the local MF (measured at different distances from the cluster center), and the relation between the present-day MF and the initial MF. We will determine how the evolution of the combined MF, and the differences between the FG and the SG MFs, can be used to explore the formation and dynamics of multiple-population GCs. As observational studies of these clusters continue to improve, our work will provide the tools needed to interpret existing data and guide future observational projects.

Proposal Category: AR

Scientific Category: Cosmology

ID: 13274

Program Title: Predicting the Performance of Satellite Dark Energy Surveys using WFC3 Grism Spectroscopy

Principal Investigator: David Wake

PI Institution: University of Wisconsin - Madison

Understanding the accelerating expansion of the universe is widely regarded as one of the most important problems in physics. As a result there are several very large future surveys planned that aim make precise measurements of the properties of this "dark energy".
Two of the most ambitious are the satellite missions WFIRST and Euclid, both of which intend to undertake enormous galaxy redshift surveys of emission line galaxies at z > 0.7 using near-IR low resolution slitless spectroscopy. In order to properly plan and optimize these ambitious projects one needs to know the number and clustering amplitude of these emission line galaxies, how these depends on redshift and line flux, and how well low resolution slitless spectroscopy performs at acquiring reliable redshifts. Currently all of these are poorly known.
Fortunately the WFC3 G141 grism is closely matched to the current instrumental designs of WFIRST and Euclid providing a unique resource with which to answer these questions. The data already taken for the 3D-HST Treasury survey provide more than enough depth and sufficient area to make the required space density and clustering measurements to effectively answer these questions. Further, the multi-band photometry available in these fields greatly helps with redshift measurements, allowing a precise analysis of the likely redshift completeness that can be obtained from just the G141 grism and which additional photometric bands are optimal for redshift success. We propose to use this archival grism data to make these measurements using the findings to investigate the survey design trade offs and find optimal survey designs for a future space based dark energy survey.

Proposal Category: AR

Scientific Category: ISM in External Galaxies

ID: 13275

Program Title: The Skeleton in the Closet: Testing the Effect of HII Region Self-Enrichment Using Archival STIS Data

Principal Investigator: Jessica Werk

PI Institution: University of California - Santa Cruz

The idea that massive stars self-enrich their immediate surroundings on very short timescales has haunted emission-line spectroscopists for the last 27 years. Kunth and Sargent (1986) were the first to draw attention to this potentially significant flaw in the common practice of using HII regions to trace galaxy metallicity. In the years since, we have made little progress observationally in understanding the impact of the metal-rich winds of massive stars on the derived chemical abundances of their HII regions. Nonetheless, metallicity, as determined from emission line nebulae, remains one of the most important diagnostic tools of the extragalactic astronomer.

We propose an archival study using STIS FUV spectra (E140M and E140H) of numerous massive stars in the LMC (11 total) and SMC (37 total) to determine the neutral gas-phase abundances along these lines-of-sight. We will then compare these results for the metal content of the neutral ISM to the ionized gas metallicities along the same lines-of-sight determined from ground-based optical spectroscopy of the local HII regions. This proposed study represents the first direct observational test of HII region self-enrichment on parsec-sized scales. As such, it will be a large step forward in finally confronting the skeleton in the astronomer's closet that is HII region self-enrichment.

Proposal Category: AR
Scientific Category: Hot Stars
ID: 13276
Program Title: Multidimensional and Radiation Hydrodynamics Simulations of Superluminous Supernovae

Principal Investigator: J. Wheeler
PI Institution: University of Texas at Austin

We propose to perform multi-parameter, multi-dimensional hydrodynamics simulations of superluminous supernova progenitor models; in particular, pair instability supernovae and violent supernova ejecta - circumstellar matter interactions. Non-local thermodynamic equillibrium radiative transfer calculations will be used to post-process the simulation data to provide us with model spectra and light curves to be directly compared to observations of superluminous supernovae. This work will include a parameteric study of evolutionary models of massive progenitor stars that include the effects of rotation and magnetic fields and will be used as initial models for the hydrodynamics simulations. Our extensive modeling of the radiative properties of mechanisms that could power superluminous supernovae will provide insight on the issue of their observed striking photometric and spectroscopic diversity and also on the role of these extraordinary explosions in enriching the primeval Universe with metals, setting the stage for future generations of stars to form. Such primordial explosions from the first stars are relevant to the HST New Frontiers Program and a key target of upcoming NASA missions such as the JWST and WFIRST.

Proposal Category: AR
Scientific Category: Hot Stars
ID: 13277
Program Title: Measuring of the Progenitor Masses of Historic Supernovae

Principal Investigator: Benjamin Williams
PI Institution: University of Washington

Using resolved stellar photometry from archival HST imaging along with stellar population analysis, we propose to constrain the progenitor masses of 24 historic SNe, increasing the total number of historic SNe with well-defined masses to 30. More than doubling the sample of SNe with progenitor mass measurements will greatly improve constraints on models of massive star evolution and the production of SNe. We will obtain these measurements with an approach that obviates the need for precursor imaging. We measure the masses of SNe precursors by analyzing the stellar populations of stars surrounding the SNe. Using well-established techniques of stellar population modeling, we can age-date the coeval population of young stars surrounding each core-collapse SN. The resulting age places strong constraints on the mass of the precursor using the well-understood properties of main-sequence stars. The proposed method works even when there is no imaging prior to the SN, or when the SN position is only localized to within a few arcseconds. Hence our proposed technique can be applied to all historic SNe within 8 Mpc with broadband imaging in the HST archive.

Proposal Category: AR
Scientific Category: Unresolved Stellar Populations
ID: 13278
Program Title: A new window on galactic suburbia with CSI, CANDELS, and GOODS-S

Principal Investigator: Rik Williams

PI Institution: Carnegie Institution of Washington

While environmental effects on galaxies are seen clearly in dramatic environments like clusters and voids, most galaxies live in far more prosaic group environments of varying richness. Since typical groups consist of a relatively small handful of galaxies spread over a relatively large area, they have proven particularly difficult to detect and characterize up to high redshifts. With the Carnegie-Spitzer-IMACS (CSI) survey, we have developed the first large-scale, stellar mass-selected group catalog extending to z=1.2, and directly measured the hierarchical growth of groups therefrom. We are now embarking on a program to study in detail the influence of these groups on their galaxy populations through a combination of Magellan follow-up spectroscopy and deep public near-IR datasets. With the HST archival study proposed here, we will fold in the spectacular CANDELS and GOODS WFC3/ACS imaging in two of the CSI fields, tracking for the first time the morphological and structural transformations in ~30 stellar mass-selected groups (containing ~300-400 group galaxies) to z=1.2.

Proposal Category: AR
Scientific Category: Cosmology
ID: 13279
Program Title: Characterizing the Young Galaxies at Cosmic Dawn

Principal Investigator: Wei Zheng

PI Institution: The Johns Hopkins University

We propose to analyze the data of the Hubble Frontier Fields, in order to discover and study galaxies at the highest redshifts and to an unprecedented depth. The redshift range of z~10-12 marks the beginning of the IGM reionization and remains as HST's last frontier. In the framework of the CLASH and related projects, our team has succeeded in finding the most distant galaxies. We will carry out a systematic search for galaxy candidates at z~10-12 in the proposed deep observations. At this redshift range, most of the spectral features are shifted longward of the WFC3/IR bands, and additional data are therefore needed in order to secure the candidates and study their intrinsic properties. We will (1) obtain deep photometry in complementary ground-based K-band observations; (2) estimate the global star-formation rate density; (3) measure the sources' UV continuum slope and (4) carry out ALMA observations to study the dust content. Finally, we will estimate the effect of these young galaxies in ionizing the IGM. Our study will serve as

an ideal bridge between HST and JWST in exploring the cosmic dawn.

Proposal Category: GO
Scientific Category: Cool Stars
ID: 13280
Program Title: Evolution of heterogeneous cloud structure through the T dwarf sequence

Principal Investigator: Esther Buenzli
PI Institution: University of Arizona

We propose to use time-resolved grism observations of three spectroscopically-variable T dwarfs to test theoretical models of cloud evolution in cool brown dwarfs. The overall spectral evolution of brown dwarfs is driven by two main factors: changes in temperatures and changes in the cloud structure. Models predict that the drastic change in spectral characteristics between L and T dwarfs stems primarily from cloud dispersal, either through hole growth or thinning due to rainout. We have used the WFC3 IR grism to carry out the first successful spectroscopic variability study of brown dwarfs with intriguing results: two T2 dwarfs show evidence for a mixed thick and thin cloud structure, but no cloud holes; a T6 dwarf exhibits multiple out-of-phase variable components, with the phase lag correlating with the pressure probed at that wavelength.

Do these results show a systematic pattern of cloud evolution? To further probe this complex behavior, we propose to expand coverage to a broader range of spectral types. We target 3 T dwarfs (T3.5, T4.5, T6) that are identified as spectroscopic variables from our SNAP survey. We will combine time-resolved WFC3/G141 grism data with simultaneous Spitzer/IRAC photometry to follow their variability over a substantial fraction of a rotation period. We will get unique horizontal and vertical structure information by probing several pressure levels simultaneously. We can then compare the heterogeneous atmospheres of T dwarfs at three distinct cloud dissipation stages for two objects each: the still cloudy T2s, the T4s near the end of the L/T transition, and the T6s, where silicate clouds should have disappeared but new clouds may appear.

Proposal Category: GO
Scientific Category: Quasar Absorption Lines
ID: 13281
Program Title: Illuminating the Dark Phases of Galaxy-Formation with the Help of a z=2.4 Quasar

Principal Investigator: Sebastiano Cantalupo
PI Institution: University of California - Santa Cruz

Galaxy formation occurs along the densest regions of the Intergalactic Medium (IGM) where the gas can collapse and form stars. However, despite their importance, the phases preceding substantial star formation are usually unobservable and thus poorly constrained. How is the IGM converted into stars at high-z and what is the efficiency of this process? The aim of this project is to answer these questions taking advantage of a new and, so far, unique

dataset: "dark" galaxies fluorescently illuminated by a bright quasar at z=2.4, recently discovered by Cantalupo et al. with deep Ly-alpha imaging on the VLT. Differently from any previous Ly-alpha survey, fluorescent emission provides a direct constraint on the gas distribution independent of any associated star formation. We have discovered a large number of high Equivalent Width (>240A) objects for which the emission is likely powered by fluorescence. These are the best candidates for "dark" galaxies currently known. Unfortunately they are spatially unresolved in our ground-based observations: the study of this new category of objects requires space-based imaging for any major advancement. A direct measurement of the star formation efficiency (SFE) of these clouds would represent a major breakthrough in the study of galaxy-formation. HST imaging will provide the key elements to achieve this goal: i) resolved Ly-alpha imaging with WFC3, providing the source sizes and gas mass; ii) ACS imaging at rest-frame 1500A, providing a measurement of recent SFR. Combined together, these observations will provide the first direct constraint on the size, gas mass and SFE of the lowest mass haloes at high-z.

Proposal Category:	GO
Scientific Category:	Resolved Stellar Populations
ID:	13282
Program Title:	A Search for Surviving Companions of Type Ia Supernovae in the Large Magellanic Cloud
Principal Investigator:	You-Hua Chu
PI Institution:	University of Illinois at Urbana - Champaign

Type Ia Supernovae (SNe) are widely recognized for their use as standardizable candles. There are two contrasting theories for their origin: a double-degenerate origin that is the result of the merger of two white dwarfs (WDs) and a single-degenerate origin in which a WD accretes material from a non-degenerate companion. The identification of surviving companions indicates a single-degenerate origin and, by comparing observations to model predictions, we can identify potential companions in the region of the SNR. The LMC is an ideal environment for the observation of SNe due to its proximity, orientation, and relatively low extinction. We have identified 9 Type Ia SNRs in the LMC that lack full data sets but are suitable for a search for surviving companions. We request B, V, I, and H-alpha observations of these SNRs. Photometry from these regions will enable us to find potential surviving companions. We further request J and H band observations of SNR 0509-67.5 in order to determine the spectral energy distribution and the nature of a point source in a diffuse patch of emission near its center. We will also use the BVI images to determine the star formation history in order to constraint the delay time of these Type Ia SNe.

Proposal Category:	GO
Scientific Category:	ISM in External Galaxies
ID:	13283
Program Title:	Testing ISM Evolution Models with Gravitational Lenses
Principal Investigator:	Xinyu Dai

PI Institution: University of Oklahoma Norman Campus

The inter-stellar medium (ISM) has been well studied in the Milky Way and nearby galaxies. However, less is known about ISM properties of cosmologically distant galaxies. We propose to study the ISM properties of moderate redshift galaxies using lens galaxies, and compare the measurements with the ISM evolution models. In particular, we plan to use COS to measure the gas column denisty through the damped Lyman_alpha absorption system of the lens B1152 +199, where our existing constraints on ISM properties are in conflict with ISM evolution model predictions. The COS observations will break the degeneracy between neutral hydrogen column density and metallicity in our existing measurements from the X-ray data, and provide accurate measurements of dust-metal-gas ratios of this galaxy, which will in turn constrain ISM evolution models at z~0.5.

Proposal Category: GO

Scientific Category: Hot Stars

ID: 13284

Program Title: Unravelling the evolution and accretion morphology of an extraordinary black hole X-ray binary

Principal Investigator: Nathalie Degenaar

PI Institution: University of Michigan

The process of accretion via an accretion disk is a fundamental aspect of several areas of Astrophysics. Ultraviolet (UV) observations of quiescent X-ray binaries offer the unique opportunity to study cool, gaseous accretion disks around black holes in a very low mass-accretion regime. We propose to study the quiescent accretion disk of the recently discovered Galactic black hole X-ray binary Swift J1357.2-0933, using FUV spectroscopic observations with the HST-COS. This stellar-mass black hole shares a set of properties that make it a unique target that can offer a new, unprecedented view of the quiescent accretion flow: the binary is viewed at high inclination and is located nearby (~1.6 kpc) at high Galactic latitude (b=+50 deg), which causes an unprecedented low reddening of E(B-V)=0.02 mag. Furthermore, Swift J1357.2-0933 has a very short orbital period of only ~2.8 hr, which points towards an unusual evolutionary history. The proposed HST-COS FUV spectroscopic observations will be employed to study the accretion morphology using the continuum emission, whereas the line emission patterns and abundances serve as a tracer of emission site of the UV radiation and the evolutionary stage of the binary.

Proposal Category: GO

Scientific Category: AGN QUASARS

ID: 13285

Program Title: WFC3 imaging and galaxy subtraction for the Kepler BL Lac W2R1926+42

Principal Investigator: Rick Edelson

PI Institution: University of Maryland

We request a single GO orbit for WFC3 imaging to measure the underlying galaxy in W2R1926+42, the only known rapidly-variable BL Lac in the Kepler field. Kepler is producing a light curve of unprecedented detail and quality, sampled once every minute with ~1% errors and ~90% duty cycle, eventually to span many years. This will be >3 orders of magnitude longer than previous quasi-continuous BL Lac optical monitoring.

Lower cadence Kepler monitoring demonstrates that so-called "blazar microvariability" (previously hinted at in short ~12 hr light curve snippets) is the result of strong, rapid flaring (>10% in ~1 hr) interspersed with much longer periods (days) of relative quiescence. These data have allowed the first measurement of the optical PSD of a BL Lac, indicating a ~4 hr timescale. They also show an approximately lognormal distribution of fluxes as well as a correlation between rms variability and flux, relations that have previously been associated with Seyfert 1 accretion disks. This is interesting because beamed jet emission, not accretion disk emission, is believed to dominate the output in BL Lacs.

However the analysis is complicated by a large and unknown flux offset (up to ~88% of the mean flux) introduced because the underlying galaxy contaminates the light curve measured with Kepler's large (~4") pixels. The WFC3 has a factor of ~100 higher resolution, providing much more suitable data for resolving the galaxy, determining its contribution, and correcting the light curve. Accurate subtraction of this non-variable component will allow improved constraints on the physical processes responsible for the variability.

Proposal Category: GO

Scientific Category: Hot Stars

ID: 13286

Program Title: Understanding the Progenitor Systems, Explosion Mechanisms, and Cosmological Utility of Type Ia Supernovae

Principal Investigator: Ryan Foley

PI Institution: Smithsonian Institution Astrophysical Observatory

Despite using Type Ia supernovae (SN Ia) to precisely measure cosmological parameters, we still do not know basic facts about the progenitor systems and explosions. Theory suggests that changing the metallicity of a SN Ia progenitor will change its peak luminosity, but not its light-curve shape. As a result, this effect should lead to an increase in Hubble scatter, reducing the precision with which we can measure distances. Additionally, if the average progenitor metallicity changes with redshift, cosmological measurements could be biased. Models also indicate that changing the progenitor metallicity will have relatively little effect on the appearance of optical SN data, but significantly change UV spectra. These data can only be obtained with HST.

We recently published the first robust detection of two SN Ia with different progenitor metallicities. These "twin" SN had nearly identical optical spectra and light-curve shapes, but different UV spectra and peak luminosities, consistent with the models. We now must increase the sample of SN Ia with good UV spectral time series to investigate the impact of metallicity on SN properties. To do this, we plan to obtain UV spectral time series of 3 SN Ia, more than doubling the sample. UV observations are critical to the understanding of SN Ia explosions and progenitors. This is our best opportunity to further our understanding of SN Ia while directly improving the utility of SN Ia for cosmology.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13287
Program Title: Late-Time UV Spectroscopic Signatures from Circumstellar Interaction in Type IIn Supernovae

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

Type IIn supernovae (SNe IIn) are defined by their relatively narrow spectral features associated with a dense circumstellar medium (CSM) formed by the progenitor star. The nature of the progenitors and mass loss remains relatively unknown. Shock interaction with the dense CSM offers an important probe of the CSM characteristics, progenitor mass-loss history, and ultimately the progenitor itself. While most supernovae tend to be faint in the UV at late times (>200 days), shock interaction and dust formation in the dense CSM often result in significant emission ranging from X-ray to radio for many years post-explosion. Here we propose HST/STIS observations of 4 relatively bright, nearby SNe IIn that reflect the diversity and significance of the subclass. The SNe 2005ip, 2006gy, 20009ip, and 2010jl are some of the most well-studied SNe IIn, and our team has already compiled a comprehensive set of multi-wavelength data that has resulted in numerous publications, but the UV remains largely unexplored. Recent observations indicate these SNe are still detectable. UV observations will (1) constrain the CSM characteristics, including geometry and composition, (2) confirm shock interaction as the heating source for late-time emission from warm dust, and (3) explore the possible presence of a scattered-light echo in SN 2006gy. Coinciding with Cycle 21's UV Initiative, this program offers new insights regarding both the progenitor and explosion characteristics of the SN IIn subclass.

Proposal Category: GO
Scientific Category: Cosmology
ID: 13288
Program Title: PG 1424+240: Too Distant to be Seen?

Principal Investigator: Amy Furniss
PI Institution: University of California - Santa Cruz

The propagation of very-high-energy (VHE; E>100 GeV) gamma rays is an increasing puzzle currently being unveiled by the combined observational power of Fermi, VERITAS and HST. Recent HST/COS observations of PG 1424+240 show the VHE blazar to be at the groundbreaking distance of z>0.6035, stirring fundamental questions regarding the validity of standard blazar emission mechanisms and the expected pair production interaction between VHE and extragalactic background light (EBL) photons. Unfortunately, the measurement which provided the redshift limit is constrained by the COS spectral coverage, and could be pushed even higher with spectral coverage above 1750 A. While unprecedented limits on the EBL will result if the blazar is found to reside at any distance beyond z=0.6, all currently available EBL and broadband blazar emission models will be negated if a redshift beyond z~0.7 is found. The propagation of VHE gamma rays from a source at z>0.7 will demand the use of exotic physics (e. g. axion/gamma-ray "oscillations") to explain the unexpectedly long gamma-ray path length. We propose STIS/E230M observations of PG 1424+240 to probe intervening Lyman-alpha absorbers which can provide evidence that this gamma-ray blazar resides at a redshift greater than z=0.6.

Proposal Category:	GO
Scientific Category:	Hot Stars
ID:	13289
Program Title:	RXJ0439.8-6809: the hottest pre-white dwarf, or the first double-degenerate supersoft X-ray source?
Principal Investigator:	Boris Gaensicke
PI Institution:	The University of Warwick

The supersoft X-ray source RXJ0439.8-6809, identified with a faint (V=21.7) very blue star in the direction of the LMC is one of the most extreme stellar objects known. Current models require it to be either: (a) the hottest (Teff~300000K) and most massive known pre-white dwarf. In this case, it would allow a real-time observational test of stellar evolution theory, as it will evolve along the white dwarf cooling track by measurable amounts within a decade; or: (b) the first known double degenerate supersoft X-ray source, i.e. an interacting binary with a shell-burning accreting white dwarf and a degenerate donor star, which would make it a very good candidate for a type Ia supernova progenitor. Alas, despite major observational efforts, including an exploratory 1-orbit Cycle 7 HST low-resolution ultraviolet spectrum, it is so far not possible to distinguish between these two scenarii. We propose to invest a modest amount of HST/COS time to finally determine the true nature of RXJ0439.8-6809. Crucially, we will obtain the first high-resolution ultraviolet spectrum of this system to confirm the LMC membership of RXJ0439.8-6809 from the detection of interstellar absorption lines at the LMC systemic velocity. In addition, we will use this spectrum to obtain a second-epoch effective temperature measurement, which we will compare that from Cycle 7. The excellent flux calibration of HST will easily detect a change of a few 10000K, which is predicted for the evolution of a massive white dwarf over the fifteen-year baseline (Cycle 7 to 21)

Proposal Category:	GO
Scientific Category:	Hot Stars
ID:	13290
Program Title:	The hypervelocity hot subdwarf US 708 - remnant of a double-detonation SN Ia?
Principal Investigator:	Stephan Geier
PI Institution:	Universitat Erlangen-Nurnberg

Type Ia supernovae (SN Ia) are the most important standard candles for measuring the expansion history of the universe. The thermonuclear explosion of a white dwarf can explain their observed properties, but neither the progenitor systems nor any stellar remnants have been conclusively identified. Underluminous SN Ia have been proposed to originate from a so-called double-detonation of a white dwarf. After a critical amount of helium is deposited on the surface through accretion from a close companion, the helium is ignited causing a detonation wave that triggers the explosion of the white dwarf itself. The helium star will then be ejected at so large a velocity that it will escape the Galaxy. The predicted properties of this remnant are an excellent match to the so-called hypervelocity star US 708, a hot, helium-rich star moving at more than 750 km/s, sufficient to leave the Galaxy.
Here we propose medium-resolution COS spectroscopy to measure the vsini of the hypervelocity He-sdO US 708 for

the first time and to search for abundance anomalies caused by pollution through an SN Ia event. This will allow us to test the double-detonation scenario with sdB donor empirically.

Proposal Category:	GO
Scientific Category:	Unresolved Stellar Populations
ID:	13291
Program Title:	Resolving internal structures of the progenitors of early-type galaxies in a vigorously forming cluster at z=2.5
Principal Investigator:	Masao Hayashi
PI Institution:	National Astronomical Observatory of Japan (NAOJ)

In our recent near-infrared narrow-band imaging surveys, we have identified the densest complex of Halpha emitters associated to a radio galaxy at z=2.5. Together with a large statistical excess of massive red galaxies (Distant Red Galaxies: DRGs), this region is probably the best candidate of a proto-cluster which is destined to evolve to a rich galaxy cluster today dominated by early-type galaxies. Therefore we are surely witnessing the clustered vigorous formation of the progenitors of present-day early-type galaxies. As such, this proto-cluster serves us the unique opportunity to investigate the physical processes in their formation and early evolution, and its environmental dependence for the first time. Note that because our targets are strongly clustered, we can efficiently make a statistical sample with a small number of pointings hence a relatively short investment of time. By spatially resolving the morphologies and internal structures of these galaxies by the proposed high-resolution HST imaging with ACS/F814W and WFC3/F160W, we will focus on the following critical issues;
(1) first appearance of the morphology-density relation,
(2) identification of the progenitors of massive, quiescent, compact galaxies,
(3) environmental dependence of the mass-size relation, and
(4) frequency of clumps/mergers and the mode of star formation (compactness/dustiness).
The proposed observations will shed light on the physical processes "in action" on the progenitors of massive early-type galaxies in clusters for the first time.

Proposal Category:	GO
Scientific Category:	Resolved Star Formation
ID:	13292
Program Title:	Dissecting star formation in N159
Principal Investigator:	Remy Indebetouw
PI Institution:	The University of Virginia

We propose to investigate star formation as a function of time, space, and mass in the Large Magellanic Cloud star formation region N159. We will combine HST photometry in V, I, J, H, and Halpha equivalent filters with our already scheduled Atacama Large (sub) Millimeter Array (ALMA; PI Fukui) and our existing Australia Telescope Compact Array (ATCA; PI Seale and PI Chen) observations. These datasets will allow us for the first time to completely characterize

protostars, HII regions, and molecular gas in this reduced-metallicity region. The region is a remarkable laboratory, containing at once a spontaneously cluster-forming giant molecular cloud (GMC), an arguably triggered star-forming GMC, and a more quiescent GMC.

We will use color-magnitude diagram (CMD) and spectral energy distribution (SED) modeling to separate redenning, circumstellar dust emission, and pre-main-sequence spectral type for each star, mapping not only current star formation activity but its history (over the last 50Myr using pre-main-sequence stars, and over a Hubble time using classical CMD fitting). We will use Halpha excess to further characterize the HII regions and all currently accreting protostars with ages up to 50 Myr. We will resolve many limitations of previous Spitzer-based star formation studies, and search for variations in the stellar initial mass function. We will test whether there is a gas density threshold for star formation, and investigate the extent to which environment and feedback also play a role in how galaxies evolve by turning gas into stars.

Proposal Category: GO
Scientific Category: ISM in External Galaxies
ID: 13293
Program Title: Green Pea Galaxies: Extreme, Optically-Thin Starbursts?

Principal Investigator: Anne Jaskot
PI Institution: University of Michigan

The high UV luminosities, compact sizes, and enormous ionization parameters of the Green Pea galaxies make them some of the most extreme starburst galaxies known. Most importantly, due to their unusual emission line ratios and high specific star formation rates, the Green Peas are the best candidates for escaping ionizing radiation in the nearby Universe. We propose to study four Green Peas with COS FUV spectra and ACS emission line imaging to constrain the Lyman continuum (LyC) escape fraction and determine the origin of high ionization emission in these galaxies. COS spectra will set strong limits on the LyC optical depth via the residual intensity in the CII 1335 line, while the NV 1240 line will constrain the stellar population's age and ionizing flux. We will also observe the starbursts with ACS ramp filters in [OII], [OIII], HeII, and H-beta to determine whether the nebular emission is consistent with a low LyC optical depth. The [OIII]/[OII] ratio map will reveal the ionization structure of the emitting gas. If the [OIII] emission is found to be more spatially extended than the [OII] in any regions, it will imply that the regions are most likely optically thin. If HeII is found to be spatially offset from the dominant nebular emission, then we infer the presence of shocks. Correcting for this shock contribution to the observed emission is critical to accurately evaluate the LyC optical depth. These observations will either reveal the Green Peas as a class of galaxies having substantial LyC escape fractions or demonstrate that even some of the most extreme galaxies in the nearby Universe are optically thick.

Proposal Category: GO
Scientific Category: Unresolved Stellar Populations
ID: 13294
Program Title: Characterizing the formation of the primordial red sequence

Principal Investigator: Alexander Karim

PI Institution: University of Durham

We request six orbits of HST/WFC3-IR to complement existing CANDELS imaging for a detailed and direct study of the formation properties of the very first massive red sequence galaxies.
Our unique sample of millimeter-identified starbursts with spectroscopically confirmed redshifts z>4 is the prime testbed to probe the formation process of massive galaxies in the very early Universe.
Given the complicated selection methods to reveal such sources, only recently the vast multi-wavelength coverage of the COSMOS field has allowed to establish this uniquely representative sample of the earliest population of massive starbursts. Their number density has been shown to match that of the very early (z~2) red sequence of massive and intriguingly compact galaxies, hinting to a direct evolutionary link of both populations. In order to establish this link -- particularly that our starbursts are prone to produce a compact remnant -- we need to thoroughly probe both, the heavily obscured regions within these generally dust-rich sources as well as the relatively unobscured patches. Scheduled high-resolution ALMA observations will yield detailed dynamics and direct views of the dust distribution within our targets. However, the high resolution WFC3-IR reaches at rest-frame (near) ultraviolet wavelengths is the only way to allow for a full view of the star formation activity and, for determining the detailed dust extinction processes across our targets.
The combined data will yield a unique opportunity to understand massive galaxy formation and dust accumulation within 1.5 Billion years after the Big Bang.

Proposal Category: GO
Scientific Category: Resolved Stellar Populations
ID: 13295
Program Title: Do the globular clusters in the Fornax dSph have multiple stellar populations?

Principal Investigator: Soeren Larsen

PI Institution: Radboud Universiteit Nijmegen

We propose to obtain WFC3 F343N-band imaging of the four most metal-poor globular clusters (GCs) in the Fornax dwarf spheroidal galaxy. With these data, we will establish whether red giant branch (RGB) stars in the clusters show a spread in their abundances of nitrogen. This will tell us whether the Fornax GCs host multiple stellar populations, as appears to be the case in most Galactic GCs.
The Fornax dSph is of special interest in this context because a very large fraction (about 20%-25%) of its metal-poor stars ([Fe/H]<-2) belong to the four most metal-poor GCs. N-body simulations suggest it is highly unlikely that a large number of field stars have been lost due to tidal interaction with the Milky Way. The GCs could therefore, at most, have been a factor of 5 more massive initially, or otherwise more metal-poor field stars should be observed. This result is in tension with some leading scenarios for the origin of multiple populations via self-enrichment in GCs, which require GCs to have been at least a factor of 10 more massive initially.
It is therefore crucial to establish whether the Fornax GCs do indeed host multiple stellar populations, and in what proportion. If they do, alternative explanations for the origin of multiple populations would have to be sought, which do not require a large number of first-generation stars to have been lost from the clusters (for example, by invoking a top-heavy first-generation IMF or accretion of additional gas). If they do not, this would have the interesting consequence that GC formation in the Fornax dSph differed significantly from that in the Milky Way.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13296

Program Title: The nuclear outflow in PDS 456

Principal Investigator: Paul O'Brien

PI Institution: University of Leicester

PDS 456 is the most luminous object in the local universe and has one of the most extreme X-ray and UV spectra of any active galactic nucleus. The X-ray data reveal a massive, ionised outflow, which carries as much kinetic energy as the bolometric output of this quasar. Such outflows are thought to be disk driven, should be common when AGN are feeding/merging and may explain the M - sigma relation through a feedback mechanism. Situated at low redshift (z=0.184), PDS 456 provides an excellent opportunity to study such an outflow in detail. A short HST/STIS observation taken in 2000 also revealed an extraordinary UV spectrum, including the most blueshifted CIV emission line know (at -5000 km s-1) and a broad, blueshifted absorption feature probably due either to Ly-alpha or NV 1240 angstroms. More recently, PDS 456 has been shown to have a highly variable X-ray spectrum, and during 2013/14 we will monitor the outflow in this quasar using large programs allocated on Suzaku and XMM-Newton. Here we request a HST/COS observation towards the end of the X-ray monitoring campaign to provide contemporaneous UV data in order to constrain the physical properties of the outflow. In particular, we wish to search for associated UV/X-ray absorption features and relate the UV emission and absorption characteristics of PDS 456.

Proposal Category: GO

Scientific Category: Resolved Stellar Populations

ID: 13297

Program Title: The HST Legacy Survey of Galactic Globular Clusters: Shedding UV Light on Their Populations and Formation

Principal Investigator: Giampaolo Piotto

PI Institution: Universita degli Studi di Padova

This is a UV-initiative proposal to complement the existing F606W and F814W database of the ACS Globular Cluster (GC) Treasury by imaging most of its clusters through UV/blue WFC3/UVIS filters F275W, F336W and F438W. This "magic trio" of filters has shown an uncanny ability to disentangle and characterize multiple-population (MP) patterns, in a way that is exquisitely sensitive to C, N, and O abundance variations. Combination of these passbands with the optical ones also gives the best leverage for measuring helium enrichment. The dozen clusters so far observed in these bands exhibit a bewildering variety of MP patterns, so that only a wide survey can map the full variance of the phenomenon. This ubiquity of multiple stellar generations in GCs has made the formation of these cornerstone objects more intriguing than ever; GC formation and the origin of their MPs have now become one and the same problem.

Our resulting five-band Treasury database will also provide unique tools to address a wide variety of other issues, such as: the advanced evolution of intermediate-mass stars; their chemical yields and contribution to the chemical evolution of galaxies; the calibration of UV-optical colors for unresolved stellar systems; the nature of the second parameter(s) that control the morphology of the horizontal branch; the identification and characterization of blue stragglers, high-energy sources, optical counterparts of millisecond pulsars, and other exotica that tend to congregate in globular clusters. Thus, an extremely wide scientific return will come from this HST legacy database.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13298
Program Title: Radio-quiet Quasars with Extremely Weak Emission Lines: a New Perspective on Quasar Unification

Principal Investigator: Richard Plotkin
PI Institution: University of Michigan

Over the past 15 years, examples of exotic radio-quiet quasars with intrinsically weak or absent broad emission line regions (BELRs) have emerged from large-scale spectroscopic sky surveys. Such types of weak-lined quasars (hereafter WLQs) challenge both the standard orientation-based quasar unification paradigm, and also quasar models that explicitly include factors beyond orientation (e.g., "disk+wind" BELR models). WLQs thus represent a new extreme of parameter space. Here, we propose STIS UV observations (7 orbits) for six WLQs to measure their (weak) Lyalpha line properties and their UV continuum slopes. Our targets cover 0.9<z<1.4, a carefully selected redshift range that allows HST to access the spectral regime near Lyalpha, and where our existing ground-based spectra also cover longer-wavelength emission line species through at least MgII[2800 Ang]. This unprecedented spectral coverage for WLQs, combined with existing Chandra X-ray data, will allow us to compare line properties over a broad range of ionization potentials with the underlying broadband ionizing continuum. We will determine if WLQ BELRs are in an exotic ionization state due to exceptionally soft ionizing continua, or if WLQs are instead unusually gas-deficient. Understanding the physical mechanisms that prevent strong emission lines from forming will present new clues into the extent that intrinsic differences among quasars can affect their their radiative and mechanical output, which has important implications for quasar unification and for black hole feedback.

Proposal Category: GO
Scientific Category: Cool Stars
ID: 13299
Program Title: Silver Linings: Using Cloud Maps to Understand the L/T Spectral Transtion

Principal Investigator: Jacqueline Radigan
PI Institution: Space Telescope Science Institute

Recent observations in the time domain have revealed large amplitude variability for a subset of objects at the transition between cloudy L and clear T spectral types, indicative of patchy cloud coverage. We propose to obtain time-resolved near-infrared spectra of two highly variable L/T transition brown dwarfs and an unusually blue L dwarf in order to make spectrally and spatially resolved maps of their surfaces. By decomposing the spectral time series into principal components we can determine the number of different surface spectra that contribute to the variability and test whether the current paradigm---namely that variability for these objects results due to holes in the cloud layer---is accurate.

Our previous Cycle 18 observations (GO12314, PI:Apai) of two early T-dwarfs suggest a simple two-surface scenario where variability across a wide range of atmospheric pressures is correlated, and presumably governed by the horizontal distribution of condensates (Apai, Radigan & Buenzli et al., submitted), while the behavior of a T6.5 dwarf was observed to be significantly more complex (Buenzli et al. 2012). While these data are suggestive, a pattern cannot be inferred from observations of only two objects. The proposed observations will double the sample of variable L/T transition objects mapped with WFC3 grism spectroscopy from 2 to 4, and allow us to establish a pattern;

namely, do all L/T transition objects share similar spectral variations, indicative of a common mechanism and number of surface components? We will then investigate whether this pattern extends to unusually blue L-dwarfs, also hypothesized to have patchy clouds.

Proposal Category:	GO
Scientific Category:	ISM in External Galaxies
ID:	13300
Program Title:	Mapping MgII Emission in the M82 Superwind: A Rosetta Stone for Understanding Feedback in the Distant Universe
Principal Investigator:	Kate Rubin
PI Institution:	Max-Planck-Institut fur Astronomie, Heidelberg

Galactic-scale outflows driven by star formation are a pervasive feature of galaxy formation models, and are required to prevent the overproduction of low-mass galaxies by regulating their cool gas supply. Winds from star-forming galaxies are commonly observed in the local Universe and out to z~6; however, empirical constraints on the spatial extent and energetics of winds in distant systems have been very challenging to obtain. Our group has pioneered the study of outflows in emission using resonantly-scattered MgII 2796, 2803 photons, a method which has the potential to map the spatial extent and morphology of galactic winds out to z~2. To take full advantage of this technique, we request 15 orbits for WFC3/UVIS narrow-band imaging of the prototypical starburst M82 to map its superwind in MgII emission. This map will trace photons resonantly scattered from cool, photoionized gas flowing from this galaxy for the first time. Unlike optical nebular lines, scattered MgII emission is an unbiased probe of T<10^4 K material, and will thus reveal a heretofore hidden component of the M82 outflow. This pilot program will focus on a single WFC3/UVIS pointing, and will leverage an extensive suite of archival WFC3/UVIS and ACS observations including H-alpha, H-beta, [OII], [OIII] and [SII] narrow-band imaging. This HST coverage, along with existing soft X-ray and CO emission maps, will yield the most detailed constraints on the physical state of gas in a galactic superwind to date, providing a crucial link between local and high-redshift studies of this phenomenon. Such constraints are fundamental to understanding the impact of feedback processes on galaxy evolution.

Proposal Category:	GO
Scientific Category:	Quasar Absorption Lines
ID:	13301
Program Title:	Deep COS Spectra of the Two Brightest Quasars that Probe the He II Post-Reionization Era
Principal Investigator:	J. Shull
PI Institution:	University of Colorado at Boulder

We propose to obtain deep observations of the two brightest (known) He II quasars (HE2347-4342 and HS1700 +6416) using the short-wavelength mode (G130M/1222) on the Cosmic Origins Spectrograph. These are among the few percent of z ~ 3 quasars that have visible flux at the He II Ly-alpha break, owing to unusually low integrated H I column densities along their sight lines. With the new grating mode, we can obtain high-resolution spectra at short (far-ultraviolet) wavelengths (1067-1363 A) that cover the He II post-reionization epoch at 2.5 < z_{HeII} < 2.75. During this time, helium ionization fronts overlap and the intergalactic medium (IGM) becomes transparent in the 4 ryd continuum. These high-S/N, high-resolution spectra are needed to resolve individual He II absorption lines, to compare with H I (Lya) and metal-line absorbers (C IV, Si IV), and constrain QSO lifetimes and ionization-front overlap with QSO transverse-proximity surveys (Jacobsen et al. 2003; Furlanetto & Lidz 2011). The He II post-reionization epoch is of

astronomical and cosmological interest for several reasons: (1) The ionizing continua are changing rapidly, affecting QSO metal-line absorber ratios; (2) Photoelectric heating from He II changes the IGM temperature and equation of state; (3) He II-ionizing QSOs transverse to sight line constrain QSO lifetimes and ionization fronts; (4) Jeans smoothing from this extra heating may affect low-mass galaxy formation.

Proposal Category:	GO
Scientific Category:	AGN QUASARS
ID:	13302
Program Title:	COS Spectra of High-Redshift AGN: Probing Deep into the Rest-Frame Ionizing Continuum and Broad Emission Lines
Principal Investigator:	J. Shull
PI Institution:	University of Colorado at Boulder

The order-of-magnitude improvement in sensitivity of COS over previous spectrographs has increased the number of AGN available for far-UV spectroscopy covering the rest-frame EUV. In archival work, we have enlarged our composite spectrum from 22 to 150 AGN, but the maximum redshift is z_max = 1.47. We request COS/G140L observations of 11 bright AGN (z = 1.45 to 2.13) to extend the composite below 400 A and greatly improve the statistics. At these redshifts, the G140L (1105 A setting) covers 1120-2000 A, probing the rest-frame continuum and emission lines down to 360-450 A. We will observe the Lyman continuum (LyC) below the He I edge (504 A) as it approaches the He II Lya break (304 A). Obtaining 11 well-exposed QSO spectra will greatly increase our knowledge in the EUV beyond the few AGN currently observed in this band. These LyC photons are responsible for ionizing hydrogen, helium, and many metal ions, for ionizing QSO broad emission-line regions (BELR), and for heating the IGM. Characterizing the AGN spectrum in the far-UV and ionizing EUV is also a crucial ingredient for studies of accretion disk structure and QSO outflows. We will also measure (or limit) the He I continuum edge (504 A) expected in some models of accretion disks, and will identify and characterize the key QSO broad emission lines in the FUV and EUV (Ne II, Ne III, Ne V, Ne VI, Ne VIII, O II, O III, O IV, O V, O VI). Detecting multiple ions from the same element (Ne and O) will yield more accurate diagnostics of BELR temperatures and metallicities.

Proposal Category:	GO
Scientific Category:	Quasar Absorption Lines
ID:	13303
Program Title:	The Structure of MgII Absorbing Galaxies at z=2-5: Linking CGM Physics and Stellar Morphology During Galaxy Assembly
Principal Investigator:	Robert Simcoe
PI Institution:	Massachusetts Institute of Technology

Using Magellan/FIRE, we have completed the first infrared survey for MgII absorption systems in the z>2 universe. At z<0.5, such MgII absorbers are almost universally associated with ~L* galaxies. Morphological studies of these host galaxies indicate that MgII traces inflowing gas accretion and outflowing galactic winds in the circum-galactic medium (CGM); both processes are critical to the regulated growth of stellar mass. We propose a deep WFC3 imaging survey

toward 9 of our survey sightlines hosting 44 MgII absorbers to investigate the morphology-absorber connection in a unique sample spanning 2<z<5. Only HST is capable of delivering the deep, spatially resolved rest-frame optical imaging needed to measure morphological parameters and orientations of these galaxies, connecting our work directly to what has been achieved in the local universe.

Proposal Category:	GO
Scientific Category:	ISM in External Galaxies
ID:	13304
Program Title:	Mysterious ionization in cooling flow filaments: a test with deep COS FUV spectroscopy
Principal Investigator:	Grant Tremblay
PI Institution:	European Southern Observatory - Germany

The Cosmic Origins Spectrograph is capable of unraveling a two decade old mystery regarding the filamentary emission line nebulae found in the brightest cluster galaxies (BCGs) of cool core (CC) clusters. These kpc-scale filaments are characterized by elevated H-alpha luminosities and puzzling ionization states that cannot be accounted for by recombination or photionization alone, and are instead excited by an unknown ionization mechanism. The most hotly debated proposed solutions invoke thermal conduction, shocks, or cosmic-ray heating, but progress toward consensus awaits unambiguous spectral discriminants between these models that can only be found in the FUV. We propose deep (9 orbit), off-nuclear observations of two strategically selected BCGs in well-studied cool core clusters with cross-spectrum archival datasets. We also propose a shorter (5 orbit) on-nuclear observation for one of our targets to assess possible AGN contributions to the spectra. These proposed observations represent critical tests that can unambiguously discriminate between the various candidate ionziation models. Constraining the mechanisms by which CC BCG filaments are excited remains one of the most important roadblocks to a better understanding of cooling from hot ambient medium to cold star forming clouds and filaments, a process important for both galaxy and black hole growth. It is therefore important that, before HST ends its mission and we lose FUV capability, we advance our understanding of this decades old mystery.

Proposal Category:	GO
Scientific Category:	AGN QUASARS
ID:	13305
Program Title:	Do mergers matter? Testing AGN triggering mechanisms from Seyferts to Quasars
Principal Investigator:	Carolin Villforth

PI Institution: University of Florida

One of the most important open question in Active Galactic Nuclei (AGN) physics to date is how they are triggered. It is commonly assumed that mergers are the dominant triggering process for luminous quasars, while lower luminosity AGN are triggered by different, less extreme processes. However, evidence that merger triggering sets in at high AGN luminsoities is currently lacking. In a recently completed study, we have analyzed the morphologies of low-redshift (z=0.5-0.7) AGN in CDFS compared to control using quantitative morphological measures. The study was specifically designed to address the question if the importance of merger triggering rises with AGN luminosity. We found no such trends as well as no enhanced merger features compared to control. However, the AGN luminosities in our current sample do not reach the highest luminsoities at which merger triggering is believed to be prevelant, and such data can not be found in the archives. We therefore request WFC3 F160W imaging of 20 bona-fide quasars to expand our current study to quasar luminosity ranges and determine if merger triggering indeed sets in at the high luminosity end of the quasar population. The study is designed as a statistical test of the null hypothesis that mergers do not trigger AGN. In case we can not reject the null hypothesis, this would imply that mergers are not respondsible for triggering the vast majority of AGN, posing a serious problem to current theoretical models of galaxy evolution. However, if we can reject the null hypothesis and do find an enhancement of merger features over control in this sample, our results would finally determine at which AGN luminosity mergers start to matter.

Proposal Category: GO
Scientific Category: Cosmology
ID: 13306
Program Title: Is the Size Evolution of Massive Galaxies Accelerated in Cluster Environments?

Principal Investigator: Gillian Wilson

PI Institution: University of California - Riverside

At z~1.6 the main progenitors of present-day massive clusters are undergoing rapid collapse, and have the highest rates of galaxy merging and assembly. Recent observational studies have hinted at accelerated galaxy evolution in dense environments at this epoch, including increased merger rates and rapid growth in galaxy size relative to the field. We propose WFC3 G102 spectroscopy and F125W (Broad J) imaging of a sample of four massive spectroscopically-confirmed clusters at z = 1.6. Our primary scientific goal is to leverage the CANDELS Wide Legacy dataset to carry out a head-to-head comparison of the sizes of cluster members relative to the field (as a function of stellar mass and Sersic index), and quantify the role of environment in the observed rapid evolution in galaxy sizes since z = 2.

These clusters are four of the highest significance overdensities in the 50 square degree SWIRE fields, and will evolve over time to have present-day masses similar to Coma. They were detected using IRAC [3.6]-[4.5] color, which identifies galaxy overdensities regardless of optically red or blue color. A heroic ground-based spectroscopic campaign has resulted in 44 spectroscopically-confirmed members. However this sample is heavily biased toward star-forming (SF) galaxies, and WFC3 spectroscopy is essential to definitively determine cluster membership for 200 members, without bias with respect to quiescent or SF type. The F125W (rest-frame V-band) imaging is necessary to measure the sizes and morphologies of cluster members. 17-passband broadband imaging spanning UV, optical, near-IR, Spitzer IR and Herschel far-IR is already in hand.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13307

Program Title: Taking the measure of quasar winds

Principal Investigator: Nadia Zakamska

PI Institution: The Johns Hopkins University

Black hole feedback -- the strong interaction between the energy output of supermassive black holes and their surrounding environments -- is routinely invoked to explain the absence of overly luminous galaxies and the black hole / bulge correlations. Yet direct probes of this process in action are scarce and limited to small subsamples of active nuclei. We recently obtained Gemini Integral Field Unit spectroscopy of the distribution of ionized gas around luminous, obscured, radio-quiet quasars on scales 20-30 kpc. These observations provide direct evidence of strong coupling between black hole energy output and gas motions on galaxy-wide scales. We propose to image these 11 objects with the HST to obtain accurate characterization of the physical conditions in the outflowing gas, with a total request of 26 orbits. Using U-band images sensitive to the scattered light from the nucleus, we will obtain a measurement of gas density and determine the geometry of quasar illumination and obscuration. Using yellow-band images we will determine the origin of the gas and characterize host galaxy morphologies at very high quasar luminosities. We will observe one object with a narrow-band filter centered on the [OIII]5007 line to determine the geometry of ionization on small scales and to constrain the clumping of the warm dense component of quasar winds. In combination with our ground-based kinematic maps, these observations will enable us to understand the 3D structure, the energetics and the physical conditions in quasar outflows. These ground-breaking measurements will provide a clear physical picture of the black hole feedback in action.

Proposal Category: GO

Scientific Category: Extra Solar Planets

ID: 13308

Program Title: Near-IR spectroscopy of the highly inflated, hottest known Jupiter KOI-13.01

Principal Investigator: Ming Zhao

PI Institution: The Pennsylvania State University

We propose to use the WFC3 IR-G141 grism to measure the near-IR dayside emission spectrum of the highly inflated, hottest known Jupiter KOI-13.01 via secondary eclipses. The A-type host star of KOI-13.01 has the highest temperature among all known hot Jupiter hosts, producing extreme irradiation and making the planet's atmosphere probably quite different from others'. It is therefore an extreme and unique target to test exoplanetary atmosphere models and observed correlation between thermal inversion and irradiation. The host star of KOI-13.01 has a companion of same brightness and spectral type at 1.2 arcsec. Because the two stars will be well-resolved by WFC3, the stellar companion provides a unique advantage to calibrate the common-mode systematics of the eclipse light curves, enabling high precision and high fidelity spectroscopy of the planet's dayside emission. The WFC3 observations will definitively determine the presence or absence of a thermal inversion in the planet's upper atmosphere by probing the water bands between 1.1 - 1.7 microns. When combined with the Kepler nightside thermal emission measurement in visible light, the near-IR spectroscopy from WFC3 will also help tightly constrain its albedo and heat transport efficiency. Furthermore, resolving the binary and measuring the secondary eclipses will allow us to definitively verify whether the brigher star is indeed the host of the planet. This study can only be done with HST because of the ultra-high precision requisite and the coverage of water bands unavailable from ground.

Proposal Category: SNAP
Scientific Category: Unresolved Stellar Populations
ID: 13309
Program Title: UV Snapshot of Low-redshift Massive Star-forming Galaxies: Searching for the Analogs of High-redshift Clumpy Galaxies

Principal Investigator: Yicheng Guo
PI Institution: UC Santa Cruz/ UCO Lick Observatory

Most galaxies at z>1 with Milky Way stellar masses are actively forming stars at rates 10-100x higher than that of our Milky Way. More surprising was the discovery that most of the star formation resides among giant star-forming clumps. The origin, properties, and evolution of these clumps remain under debate, yet they are vital to our understanding of initial bulge formation, the evolution of early gas-rich disks, and the cold gas accretion history of galaxies. Because these clumps are often visible only in the rest-frame UV, they are easily detected in observed optical images of high redshift galaxies. But at low redshifts (0.05<z<0.25), resolving star-forming clumps is only possible with HST UV imaging. The number of current identified clumpy galaxies at 0.05<z<0.25 is far too few to measure the evolution in the frequency of clumpy star formation from high redshifts to today. To remedy this deficiency, we propose an UV snapshot survey to image a representative sample of 136 massive star-forming galaxies at 0.05<z<0.25 with the WFC3/UVIS F225W filter to: (1) determine whether any of the local clumpy galaxies are analogs to those seen at high redshift; (2) characterize the nature of these local clumps; and (3) measure the spatial distribution and evolution of star formation (SF) within these clumpy galaxies. HST's access to deep UV imaging at the required high-spatial resolution to detect and resolve local clumps is unique. The high-resolution UV images of our sample will serve as an invaluable legacy dataset for further extragalactic studies for years to come.

Proposal Category: GO
Scientific Category: ISM and Circumstellar Matter
ID: 13310
Program Title: The life and death of H2 in a UV-rich environment - Towards a better understanding of H2 excitation and destruction

Principal Investigator: Nicholas Abel
PI Institution: University of Cincinnati-Clermont College

Molecular hydrogen (H2) is the most abundant molecule in the universe. H2 is also a catalyst for the formation of other molecules like CO that are used to infer physical conditions in molecular gas. Therefore, it is crucial to understand H2 formation and destruction processes. Most existing H2 UV absorption studies sample regimes where H2 has already formed, and the level populations are thermalized. However, the Orion Veil, a thin layer immediately (~ 1 pc) in front of the Trapezium stars, offers a different environment. There, the fractional abundance of H2 is low, and UV radiation pumps H2 to high vibration and rotation levels. In this environment, comparisons between theory and observation provide stringent tests of models of H2 formation and destruction.

For the Veil, we seek to compare STIS observations of vibrationally and rotationally excited H2 absorption lines with predictions of chemical models in the Cloudy code. Model calculations predict we will detect dozens of H2 lines from high vibration and rotational levels in the wavelength range 1133-1335A. We hope to address three important questions: (1) Why do chemical models fail to reproduce the observed spectrum of H2 in high rotation and vibration levels? (2) Why are observed PDR temperatures inconsistent with known processes of heating and cooling? (3) Is the deduced H2 destruction rate consistent with recent theories of formation on grain surfaces? Answers to these

questions will significantly improve chemical models in Cloudy. Since Cloudy is publicly available, improvements in its chemical models will benefit other investigators studying the physics of molecular gas and PDRs.

Proposal Category: GO
Scientific Category: Solar System
ID: 13311
Program Title: Precise Orbit Determination for a New Horizons KBO

Principal Investigator: Susan Benecchi

PI Institution: Carnegie Institution of Washington

The New Horizons (NH) spacecraft is on its way to study the Pluto system during a flyby after which the spacecraft will be retargeted to one or more Kuiper Belt Objects (KBOs) to learn about small KBOs and the Kuiper Belt population. We are actively carrying out dedicated ground-based observations to identify a target for NH to flyby and continue to improve our analysis algorithms. To date, we have 28 discoveries including five objects that are long-range reconnaissance candidates, two that are pre-Pluto encounter observation candidates and two that current orbit predictions require about a factor of 2 more propellant than available for the targeting maneuver. Our searches are continuing in to 2013. Unfortunately, NH's trajectory line of site is within the galactic center (Sagittarius) making stellar confusion a major problem in obtaining precise astrometry and high precision orbits for these objects from the ground. HST's sensitivity, resolution and PSF stability are crucial components for determining precise orbits for these objects. We are requesting 2 TOO orbits to be triggered in the event that a candidate object is found within the targetable region. These observations will provide the required high precision astrometry, will evaluate if the NH candidate is binary (~30%) and will make a preliminary color determination to assist in fly-by planning.

Proposal Category: GO
Scientific Category: ISM in External Galaxies
ID: 13312
Program Title: The Evolution of C/O in Low Metallicity Dwarf Galaxies

Principal Investigator: Danielle Berg

PI Institution: University of Minnesota - Twin Cities

While oxygen and nitrogen have been widely observed in spiral and dwarf galaxies, the study of the next most abundant element, carbon, resides in a state of relative infancy. We propose to use COS on the HST to observe UV emission lines of carbon and oxygen for a sample of high-surface brightness low-metallicity dwarf galaxies. Combining these data with the observations of Garnett et al. (1995), we will produce the first statistically significant sample of C/O abundances in nearby dwarf galaxies. The upgrade in UV efficiency from FOS to COS and the large pool of spectra available today due to extensive surveys (e.g., the SDSS), allow us to efficiently triple the number of secure measurements. Determining the underlying trend of C with O and the scatter in C/O at a given value of O/H provide strong constraints on the nucelosynthetic origin of C. In addition, combining these data with ground-based optical spectra will show how carbon and nitrogen production are coupled, providing key insights as to the degree that carbon is a primary product of

intermediate-mass stars. Given the recent interest in possibilities of non-universal initial mass functions in low-mass (low-metallicity) galaxies, a secure characterization of the behavior of C/O is vital.

Proposal Category: GO
Scientific Category: ISM in External Galaxies
ID: 13313
Program Title: Determining attenuation laws down to the Lyman break in z~0.3 galaxies

Principal Investigator: Mederic Boquien
PI Institution: Laboratoire d'Astrophysique de Marseille

Star formation is the fundamental process transforming baryonic matter in the Universe, and governing the cycling of gas in-and-out of galaxies. Tracing accurately star formation is of critical importance to discriminate between galaxy evolution models.
The UV is where massive young stars emit the bulk of their energy and the wavelength of choice to track the evolution of the star formation across cosmic times. Presence of dust, however, impacts the UV emission from galaxies, by dimming and reddening it. Correcting the UV for dust attenuation is thus a crucial requirement to derive the physical parameters of galaxies. Significant variations from the widely used "starburst law" are observed from one galaxy to another, which may reflect systematic variations with stellar populations or galaxy morphology. These uncharacterized variations pose an important limitation to our ability to quantify properties of high-redshift galaxies, a regime where the starburst law is almost universally applied.
In order to determine and parametrize attenuation laws in the UV down to the Lyman break we propose to perform COS FUV spectroscopy on a sample of 8 star-forming galaxies at z~0.3. While broadband data can constrain dust masses and optical depth, they cannot reliably constrain the attenuation law itself due to degeneracies between the competing effects of stellar populations and dust. The combination of COS spectra with existing broadband observations will be crucial to address this issue. This will allow us to constrain dust models and will have a broad impact on the study of galaxies from the galactic neighborhood to ultra-high redshifts.

Proposal Category: GO
Scientific Category: Quasar Absorption Lines
ID: 13314
Program Title: Characterizing the Elusive Intragroup Medium and Its Role in Galaxy Evolution

Principal Investigator: Sanchayeeta Borthakur
PI Institution: The Johns Hopkins University

A large fraction of galaxies today reside in groups, and the dominant form of baryons in these groups is predicted to be a diffuse Intragroup medium (IGrM). Thus, the IGrM is not only a significant baryon repository, but must play a key role in the formation and evolution of galaxies. Despite its importance, direct observational detection of the IGrM has been limited to the most massive groups where it is hot enough to emit soft X-rays. There have been a number of possible

detections of the IGrM in the typical lower-mass groups via absorption-lines seen in the spectra of background QSOs. However, no one has yet mounted a controlled absorption-line experiment to search for the IGrM using a pre-defined sample of groups. In this proposal we request time to do this by observing a sample of 16 groups using QSO sightlines that pass within 1.5 virial radii. Our data will probe the OVI line tracing hot gas as well as the Lyman series lines and metal lines probing cooler gas. We will combine this sample with the complementary COS-Halos program (PI, Tumlinson), which mostly probes sightlines through the halos of individual isolated galaxies. This will enable us to isolate the IGrM itself (rather than gas associated with individual galaxies), probe the properties of the IGrM, and explore how individual galaxies may influence the IGrM (and vice versa). Our data will be interpreted within the context of state-of-the-art simulations of galaxy formation and the IGrM.

Proposal Category: GO
Scientific Category: Solar System
ID: 13315
Program Title: Pluto Satellite Orbits in Support of New Horizons

Principal Investigator: Marc Buie

PI Institution: Southwest Research Institute

We propose a sequence of observations that will significantly improve the orbit of P/2011 P1 and P/2012 P1 and provide useful improvements to the orbits of other satellites in the Pluto system. The orbit determination work for the newest satellite discoveries are critically needed so that New Horizons can know where to point its instruments at close approach. These data will also be useful for improved mass constraints on the outer satellites as well as refining our knowledge of the photometric properties of all objects in the Pluto system. In particular, lightcurve and color evolution will be monitored by these observations for use in constraining models of seasonal evolution on Pluto.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13316
Program Title: The Awakening of the Super-Massive Black Hole at the Center of Our Galaxy

Principal Investigator: Howard Bushouse

PI Institution: Space Telescope Science Institute

Observations of the Galactic Center have recently discovered a dense, dusty gas cloud, known as G2, infalling towards the dormant Super-Massive Black Hole (SMBH) Sgr A* at the center of our galaxy. This cloud is on a highly eccentric orbit, which should reach pericenter around September 2013. It has already started to show signs of tidal disruption by the black hole. The fragmentation of the cloud should lead to it becoming the dominant source of accretion activity over the next year or so. It is expected that high-energy emission from Sgr A* resulting from this encounter will increase significantly during and after this time. The circularization of some fraction of the cloud mass should dissipate a considerable fraction of its kinetic energy, resulting in large increases in emission at all wavelengths from the accretion disk. Multiwavelength observations are being planned to monitor the resulting flaring of Sgr A* in radio, X-rays, and gamma-rays. Near-IR observations will be crucial to this once in a lifetime opportunity, because accretion events always manifest themselves first and most often in the near-IR. We propose WFC3 IR monitoring observations of Sgr A* to be conducted simultaneously with already awarded X-ray observations from XMM-Newton. These multiwavelength observations will allow us study the radiation properties of Sgr A* as the cloud breaks up and its fragments feed gas into the central accretion flow, and will give us the ability to test features of many existing accretion models. HST/WFC3 is the only facility that can provide the long-duration and photometrically-stable near-IR measurements that are necessary.

Proposal Category: GO

Scientific Category: Cosmology

ID: 13317

Program Title: Infrared Grism Confirmation of a Strongly Lensed z ~ 11 Candidate: MACS0647-JD

Principal Investigator: Dan Coe

PI Institution: Space Telescope Science Institute

The first galaxies are the frontier of extragalactic astronomy. How and when did they form, and how did they contribute to reionization? Gravitational lensing has enabled efficient discovery of high-redshift galaxies including MACS0647-JD at z ~ 10.8 (420 Myr after the Big Bang), a strong candidate for the most distant galaxy yet known. This discovery by the CLASH Multi-Cycle Treasury program is consistent with expectations extrapolated from lower redshifts ($4 < z < 8$). The evolving luminosity function fit to these data includes sufficient numbers of faint galaxies at early times to reionize the universe. However, the discovery of MACS0647-JD is in tension with lower number densities of $z > 9$ candidates identified in deep field observations including the UDF. These field studies suggest $z > 9$ galaxies were building up in numbers much more rapidly than observed at later times. Confirmation of the z ~ 10.8 candidate is therefore paramount to our understanding of early galaxy evolution and reionization. All three strongly lensed images of MACS0647-JD are significantly detected in two HST filters (F140W and F160W). Lower redshift objects have been ruled out with high confidence, and the redshift is corroborated by our lens modeling. The strong lensing magnification provides us with a rare opportunity to confirm such a high redshift. We propose to do so with ten orbits of WFC3/IR G141 grism observations. Two orbits of F140W imaging are also required for calibration. As the first ever HST IR grism observations of a $z < 1$ cluster, this program will serve as an important pathfinder for future IR grism observations of lensed fields with HST and with the James Webb Space Telescope.

Proposal Category: GO

Scientific Category: Solar System

ID: 13318

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 (10^20 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.

Proposal Category: GO

Scientific Category: Cool Stars

ID: 13319

Program Title: COS Spectroscopy of Pulsating, Metal-Rich, Extremely Low Mass White Dwarfs

Principal Investigator: Alexandros Gianninas

PI Institution: University of Oklahoma Norman Campus

Our goal is to simultaneously probe two phenomena in newly discovered extemely low mass (ELM) He-core white dwarfs. Optical spectroscopy suggests that these ELM white dwarfs are the most metal-rich white dwarfs known. COS UV spectroscopy will establish this and map the detailed metal abundance patterns, allowing us to discriminate between a debris disk origin and radiative levitation origin for their super-solar metal abundances.
Second, optical photometry suggests that one of these targets is a pulsating white dwarf, and in fact may be the first known white dwarf with p-mode pulsations. COS time-tag capability provides a unique opportunity to confirm that this star exhibits p-mode pulsations. Such modes would probe this star even deeper than the g-mode pulsations also present, and could possibly constrain stable nuclear burning predicted in these low-mass white dwarfs.

Proposal Category: GO
Scientific Category: Resolved Stellar Populations
ID: 13320
Program Title: Unveiling the nature of ultraluminous X-ray sources via UV spectroscopy

Principal Investigator: Fabien Grise
PI Institution: Instituto de Astrofisica de Canarias

Our recent HST/Chandra study of the ultraluminous X-ray source (ULX) in NGC 5408 showed that the X-ray/UV/optical/NIR spectral energy distribution (SED) is consistent with emission from an irradiated accretion disk, while the UV/optical/NIR SED alone can also be explained as a B0I supergiant star. If the accretion disk dominates in the far-UV, then we expect to see a wealth of spectral lines features in the far-UV spectrum. If, instead, the far-UV light arises from an early B supergiant, we expect to see UV lines with strong P-Cygni profiles. To determine the physical origin of the UV/optical/NIR emission, we propose to take a deep look at the far-UV spectrum of the ULX using the unique capabilities of the Cosmic Origins Spectrograph. The spectrum obtained will definitively distinguish between an irradiated accretion disk and a supergiant companion star. Detection of UV lines is likely one of the only direct ways to constrain the physical nature of ultraluminous X-ray sources.

Proposal Category: GO
Scientific Category: ISM in External Galaxies
ID: 13321
Program Title: COS Spectroscopy of the Stephan's Quintet Giant Shock

Principal Investigator: Pierre Guillard
PI Institution: Institut d'Astrophysique Spatiale

Stephan's Quintet, the most studied compact group, is an ideal laboratory to study how kinetic energy is dissipated, how gas cools, and how star formation is triggered in galaxy interactions. It hosts a dramatic 30 kpc X-ray emitting shocked region, triggered by a 1000 km/s galaxy collision. Our Spitzer and Herschel spectroscopy has revealed that H2, C+ and OI are important coolants in the shock, with luminosities exceeding that of X-rays. However, nothing is known about UV line cooling. Our models of the collision show that the kinetic energy is dissipated through a turbulent cascade, with a large range of shock velocities (from 600 down to 10 km/s in the H2 gas), with shock-excited UV emission lines possibly dominating the energy budget at intermediate velocities. Thus, we propose to observe the brightest ones (Lya, CIV, OVI) with COS by targeting different environments in the shock. Our key science goals are to (1) quantify the contribution of the UV lines to the total gas cooling, (2) understand why, despite large H2 masses, the star formation efficiency in the shock is very low, and (3) determine the origin of the diffuse UV emission detected with GALEX in the shock (is it continuum or line emission?). These observations are crucial to determine the dissipation rate and physical state of the gas and to understand the star formation efficiency. This problem is relevant to many other active phases of galaxy evolution, ranging from shocks in infrared luminous galaxies and AGN feedback, to gas cooling and formation of the first galaxies at high z.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13322
Program Title: Time-resolved FUV Spectroscopy of a Unique White Dwarf in the Kepler Field

Principal Investigator: Donald Hoard
PI Institution: Eureka Scientific, Inc.

We propose to use 4 HST orbits to obtain time-resolved far-UV (FUV) spectra with COS of the rapidly spinning, metal-polluted white dwarf KIC~9535405, in order to explore the distribution of accreted metals over the white dwarf's surface (including the possibility that confinement by the white dwarf's magnetic field is preventing the rapid gravitational settling of heavy elements). This will enable us to explore details of the largely unknown process through which matter transitions from circumstellar space onto the WD itself. We will also obtain the chemical composition of the parent body of the accreted matter, thereby adding to the limited pool of information on direct measurements of the composition and structure of extrasolar planetary (terrestrial) bodies. The proposed HST observations will be complemented by existing, ongoing, and planned ground- and space-based (Kepler, Spitzer) observations obtained by us.

Proposal Category: GO
Scientific Category: Cool Stars
ID: 13323
Program Title: Taking the Temperature of Explosive Stellar Flares

Principal Investigator: Adam Kowalski
PI Institution: NASA Goddard Space Flight Center

State-of-the-art radiative hydrodynamic models which employ solar flare heating mechanisms are not able to produce a key observational component of stellar flares, hot blackbody emission, indicating that there is significant physics missing from our understanding of energy transport and radiation during stellar flares. Efforts to resolve this discrepancy using blue-optical spectrophotometry have proven to be insufficient to accurately constrain the temperature of this blackbody emission and more generally the depth in the atmosphere at which this emission originates. We propose to rectify this shortcoming by using HST/COS to measure the flare blackbody temperatures on the active dM4e star GJ 1243, a star whose frequency of moderate-size flares is extremely well characterized thanks to our Kepler GO-2/3 programs.

Proposal Category:	GO
Scientific Category:	Unresolved Stellar Populations
ID:	13324
Program Title:	Where cores are no more: assessing the role of dissipation in the assembly of early-type galaxies
Principal Investigator:	Davor Krajnovic
PI Institution:	Astrophysikalisches Institut Potsdam

Outcomes of violent dissipative and non-dissipative galaxy mergers are predicted to have different dynamical states and different nuclear profiles. The current paradigm is that flat (core) light profiles are results of coalescence of supermassive black holes in non-dissipative mergers of galaxies. These merger are also thought to produce remnants with low angular momentum (slow rotators) within a half-light radius. Matching the archival HST imaging with the volume-limited Atlas3D sample of nearby early-type galaxies (with integral-field stellar kinematics), indicates that the current paradigm is not complete. A recent study revealed the existence of fast rotating galaxies with core nuclear light profiles, and, more significantly, it postulated the existence of core-less slow rotators. The implication on galaxy formation scenarios of the latter finding is straightforward: dissipative mergers can create dynamically different galaxies both of high and low angular momentum. Unfortunately, the sample of Atlas3D galaxies with HST imaging misses a key set of low angular momentum objects with intermediate masses which provide the unique opportunity to (i) determine to what extent and to what upper mass limit dissipative processes dominate the formation of ETGs and (ii) to conclusively test the connection between nuclear structure and global parameters such as the stellar angular momentum, total mass and stellar velocity dispersion. We ask to observe the 12 carefully selected galaxies in this category.

Proposal Category:	GO
Scientific Category:	ISM in External Galaxies
ID:	13325
Program Title:	Pushing COS to the (Lyman-)Limit
Principal Investigator:	Claus Leitherer
PI Institution:	Space Telescope Science Institute

The newly attained UV sensitivity of COS below 1150 A opens a wavelength domain not available since the end of the FUSE mission in 2007 and enables fundamentally new UV science with HST. We take advantage of this capability and propose COS+G140L spectroscopy of three carefully selected starburst galaxies at cz =13,000 km/s to measure or place stringent limits on the intrinsic Lyman continuum, and constrain the fraction of hydrogen-ionizing photons that

escape the galaxies. Our galaxies were selected to have reliable, observed fluxes at 1000 A (based on FUSE archival spectra), and physical properties that provide the most favorable conditions for measuring the escape of Lyman continuum photons. The opacity to ionizing photons within star-forming galaxies, even in our own Galaxy, remains highly uncertain. Using Starburst99 with our newly developed set of model atmospheres, we will compute significantly improved constraints on the expected Lyman continuum. By measuring the redshifted Lyman break we can derive or set an upper limit to the escape fraction of ionizing radiation. In constrast, prior FUSE observations below 912 A are dominated by systematics due to variable background noise. The proposed observations will also enable studies of outflows, the interstellar reddening law, and stellar population properties, including star-formation rates and the stellar initial mass function. We will compare our results to existing data at higher redshift in an effort to understand the evolution of the escape fraction with redshift, and to shed light on the conditions that must have prevailed if primeval galaxies were responsible for reionizing the intergalactic medium at z >6.

Proposal Category:	GO
Scientific Category:	Unresolved Stellar Populations
ID:	13326
Program Title:	Zooming In on the Progenitors of Ultra-Luminous Supernovae with HST
Principal Investigator:	Ragnhild Lunnan
PI Institution:	Harvard University

The advent of wide-field optical time-domain surveys is providing an opportunity to discover and decipher new classes of astronomical transient phenomena. One of the most unexpected results from Pan-STARRS and other time-domain surveys is the discovery of ultra-luminous supernovae (ULSNe), with bolometric luminosities up to 100 times higher than normal core-collapse and Type Ia supernovae (SNe), and with spectra that do not match known SN classes. These ULSNe represent a new challenge to our understanding of the deaths of massive stars, the standard core-collapse picture, and the mechanism for powering optical emission in SNe. Progress in our understanding of these mysterious explosions requires detailed studies of their light curves and spectra (available from our Pan-STARRS data and ground-based follow-up), and studies of their galactic and sub-galactic environments - the focus of this HST proposal. We propose to take advantage of HST's superb angular resolution to study the locations of the ULSNe relative to their host UV light distribution as a probe of the progenitor population (similar studies of GRBs and core-collapse SNe suggest distinct types of massive star progenitors). Seven Pan-STARRS ULSN hosts will have HST imaging through our existing Cycle 19 and 20 programs, and here we propose to essentially double that sample and obtain rest-frame UV imaging of another 6 ULSN hosts (ranging in brightness from 22-25.5 mag). This will bring the Pan-STARRS sample to a comparable number as the GOODS core-collapse SNe and GRB hosts, which are also well-matched to the Pan-STARRS sample in redshift, allowing for a detailed statistical comparison between the populations.

Proposal Category:	GO
Scientific Category:	AGN QUASARS
ID:	13327
Program Title:	Proper Motions at 500 Mpc: Measuring Superluminal motions in Optical Jets with HST
Principal Investigator:	Eileen Meyer

PI Institution: Space Telescope Science Institute

Following the success of a recent archival program to measure precisely the superluminal proper motions of the relativistic jet in the nearby galaxy M87, we propose new ACS/WFC observations of three radio galaxies with optical jets previously detected by HST. The moderately deep imaging we propose will provide us with a well-sampled astrometric reference frame in order to accurately register archival HST images of these jets, using globular clusters and background galaxies to reach sub-pixel astrometric accuracy. In conjunction with archival data, the new observations will provide baselines of 20 years over which to compare the location of knots in these jets, allowing us to measure speeds for individual components with accuracies of 0.2c for the nearby source 3C 264 and 1c for 3C 346 and 3C 273. The kinematics of jets on large scales have not been previously studied, leaving open the question of whether the bright knots and compact features in the jet are standing recollimation shocks, or propogating plasma with possibly relativistic bulk motion. The latter case implies a jet that is intermittent on timescales much longer than the dynamical timescale. Observing proper motions in the optical allows us to study kinematics of compact features associated with zones of in situ particle acceleration which produce the higher-energy optical through X-ray photons, not distinctly visible in radio maps. The selected targets offer a diversity in jet power and morphological type which will allow us to better understand the AGN jet population as a whole, and put constraints on unknowns such as the jet energy content, and the impact of jets on the galaxy and cluster environment.

Proposal Category: GO
Scientific Category: Solar System
ID: 13328
Program Title: Observing Ganymede's atmosphere and auroras with COS and STIS

Principal Investigator: Jonathan Nichols

PI Institution: University of Leicester

Jupiter's satellite Ganymede is one of the solar system's most intriguing moons, and the importance of studying Ganymede is vividly highlighted by the recent selection of the ESA L-class mission JUICE. Ganymede possesses an oxygen atmosphere and the only known 'magnetosphere within a magnetosphere', and the continuous impingement of Jupiter's magnetospheric plasma on Ganymede thus makes the satellite an ideal control case for studying the interaction of any cosmic body with an external wind. Auroral emissions are crucial diagnostics of this interaction, but spectra of Ganymede's FUV auroras have only been obtained with GHRS and STIS. Fundamental outstanding questions thus remain as to the nature of this unique satellites's atmosphere and its magnetosphere, and we will use the significantly improved sensitivity of COS, combined with the imaging capabilities of STIS, to examine Ganymede's FUV atmospheric emissions in order to answer the following questions:
* How does Ganymede's magnetosphere interact with Jupiter's?
* What is the nature of Ganymede's oxygen atmosphere?
Ganymede has never been observed with COS, and STIS observations of both hemispheres have not been obtained in the same epoch, such that this program will provide the most significant advancements in our understanding of the atmosphere and magnetosphere of this enigmatic satellite for over a decade. HST is the only observatory capable of obtaining these observations and execution of this program during Cycle 21 is extremely highly desirable, since the unprecedented new information these observations will return are urgently required by those who are now designing instruments for the JUICE mission.

Proposal Category: GO
Scientific Category: Extra Solar Planets
ID: 13329

Program Title: Discovering the nature of the star-planet interaction at WASP-12b

Principal Investigator: Jonathan Nichols

PI Institution: University of Leicester

In 2010, COS produced a tantalising hint of a significant discovery: the magnetic field of an exoplanet. The ingress of the transiting 'hot-Jupiter' exoplanet WASP-12b apparently occurred earlier in the NUV than in the optical, and two hypotheses have been put forward as explanations. One is that this manifests dense shocked material in a magnetosheath formed in the supersonic stellar wind upstream of the planet's thus-revealed magnetic field, while the other is that this is caused in the absence of a planetary magnetic field by material overflowing the planet's Roche lobe at the L1 point. However, the previous observation, which was not designed to observe this phenomenon, is beset by scattered, sparse data and we do not yet understand the nature of the star-planet interaction. It is thus crucial that we now observe WASP-12b in a program specifically designed to unambiguously detect the early ingress, significantly improve the NUV lightcurve, and answer the question:
* What is the nature of the star-planet interaction at WASP-12?
No other observatory is capable of making these observations, and this proposal is highly accordant with the purpose of the Cycle 21 UV initiative. Execution in Cycle 21 is also highly desirable since the results will provide input to the LOFAR exoplanet program, which will focus on planets thought to exhibit star-planet interactions. By following a fortuitously obtained pointer, this proposal presents low risk-high impact observations, since the characterisation of star-exoplanet interactions and possibly the first detection of an exoplanetary magnetic field would be of huge scientific significance.

Proposal Category: GO

Scientific Category: AGN QUASARS

ID: 13330

Program Title: Mapping the AGN Broad Line Region by Reverberation

Principal Investigator: Bradley Peterson

PI Institution: The Ohio State University

We propose to make the first reverberation map of the detailed response of the broad UV emission lines, crucial to studies of the evolution of black hole masses across cosmic time, to the variable continuum using the Seyfert 1 galaxy NGC 5548. Reverberation mapping is the only direct method for measuring black hole masses beyond the local universe, using time resolution as a substitute for spatial resolution. This program will provide the first determination of the structure of a high-ionization broad-line region. NGC 5548 is known to vary on short time scales and has a short time lag between continuum and emission-line flux variations, assuring that physically meaningful, empirical, model-independent velocity-delay maps for the strong UV lines (C IV and Lyman alpha) can be recovered reliably given our experimental design. Realistic numerical simulations based on the known statistical properties of this source demonstrate that velocity-delay maps can be well-determined with 180 consecutive daily visits, even allowing for safing events or other occasional interruptions. Obtaining unique velocity-delay maps for strong emission lines will be a ground-breaking accomplishment for HST; these maps will clarify the nature of the broad-line region, its role in the apparently complicated accretion/outflow process, and determine definitively the veracity and accuracy of the AGN reverberation-based black hole masses that are now a key component of any study of black hole growth, evolution, and the role of feedback in the evolution of galaxies. We leverage this program with a well-designed public-domain extragalactic deep-field parallel program.

Proposal Category:	GO
Scientific Category:	Extra Solar Planets
ID:	13331
Program Title:	Confirmation and characterization of young planetary companion hidden in the HST NICMOS archive
Principal Investigator:	Laurent Pueyo
PI Institution:	The Johns Hopkins University

We propose to conduct WFC3 high contrast observations of six faint planetary candidates orbiting young (1 to 100 Myrs) stars identified in archival HST NICMOS coronagraphic data as part of our team's program AR-12652. Such rare objects are of the utmost importance to comparative exo-planetology as their physical properties reflect the initial conditions of still poorly constrained planetary formation mechanisms. Moreover directly imaged systems are precious artifacts in the expanding exo-planetary treasure trove as they are readily available for spectroscopic characterization. Our statistical analysis, which combines population synthesis models and empirical inspections of the entire NICMOS field of view for all sources observed in coronaraphic mode, almost guarantees that one of these six faint candidates is associated with its putative host star. We will conduct our observation in four near infrared filter, F125W, F160W to establish the baseline luminosity of our candidates and in F127M and F139M in order to probe the depth their water absorption features, characteristic of substellar /exo-planetary like atmospheres. Because of the youth of our targets, this program, which only requires a modest 12 HST orbits, will almost certainly identify and image a young or adolescent exo-planet.

Proposal Category:	SNAP
Scientific Category:	ISM and Circumstellar Matter
ID:	13332
Program Title:	A SNAP Survey of the Local Interstellar Medium: New NUV Observations of Stars with Archived FUV Observations
Principal Investigator:	Seth Redfield
PI Institution:	Wesleyan University

We propose to obtain high-resolution STIS E230H SNAP observations of MgII and FeII interstellar absorption lines toward stars within 100 parsecs that already have moderate or high-resolution far-UV (FUV), 900-1700 A, observations available in the MAST Archive. Fundamental properties, such as temperature, turbulence, ionization, abundances, and depletions of gas in the local interstellar medium (LISM) can be measured by coupling such observations. Due to the wide spectral range of STIS, observations to study nearby stars also contain important data about the LISM embedded within their spectra. However, unlocking this information from the intrinsically broad and often saturated FUV absorption lines of low-mass ions, (DI, CII, NI, OI), requires first understanding the kinematic structure of the gas along the line of sight. This can be achieved with high resolution spectra of high-mass ions, (FeII, MgII), which have narrow absorption lines, and can resolve each individual velocity component (interstellar cloud). Obtaining short (~10 minute) E230H observations of FeII and MgII, for stars that already have moderate or high-resolution FUV spectra, will increase the sample of LISM specta, and enable new measurements of the physical properties of the gas in our galactic neighborhood. This proposal builds on a similar SNAP program implemented in Cycle 17 which acquired 36 new observations of the LISM and demonstrated the high scientific return from such short observations. STIS is the only instrument capable of obtaining the required high resolution UV spectra now or in the foreseeable future.

Proposal Category: GO
Scientific Category: ISM in External Galaxies
ID: 13333
Program Title: Investigating the Impact of Merger Driven Shocks

Principal Investigator: Jeffrey Rich

PI Institution: Carnegie Institution of Washington

Integral field spectroscopy of NGC 3256, the most luminous system in the local universe (z<0.01), reveals a blended, composite starburst/shock spectrum with no trace of an AGN. Galaxy-wide shocks in starbursts and merging systems like NGC 3256 are a prime source of feedback, though the impact that such shocks have on the ISM and their effects on star formation remain poorly understood. The combination of wide-field, narrow-band and high-resolution achieved by WFC3 imaging allows us to probe the relationship between shocks and their hosts better than ever before. We propose to image NGC 3256 in several diagnostic lines including [O III], H-beta, [N II], H-alpha, [S II] and [O I]. High-resolution WFC3 observations will enable us to spatially resolve shocked vs. star forming regions, allowing us to isolate the superwind and starburst-ionized gas for the first time, and to estimate the total energy budget and physical characteristics of the wind and shocks in NGC 3256. A comparison with complementary data, including HST, Spitzer, Chandra and ALMA observations, will also allow us to trace obscured and unobscured star formation and their proximity to shocks and to search for shocks driven by merger-induced gas flows which could help transport gas to the observed nuclear starbursts in U/LIRGs. As the nearest extreme starburst, an infrared luminous galaxy and the host of a galactic superwind, NGC 3256 is ideally suited for an analysis of the impact of shocks and large-scale gas flows on the surrounding ISM and star formation and will serve as a key laboratory for the detailed study of a fundamental feedback process in LIRGs, which dominate cosmic star formation at high redshift.

Proposal Category: GO
Scientific Category: Cosmology
ID: 13334
Program Title: The Longest Period Cepheids, a bridge to the Hubble Constant

Principal Investigator: Adam Riess

PI Institution: The Johns Hopkins University

An independent measurement of the Hubble Constant with 1-2% precision offers enormous leverage for resolving outstanding cosmological investigations including the the precise geometry of space, the properties of the elusive neutrinos, and the nature of dark energy. It would contribute the equivalent of nearly doubling the size of other near term cosmological surveys like DES, BOSS and Pan-STARRS. We are building a new distance ladder to double the current precision of the Hubble constant to <2% by attacking the largest unaddressed obstacle to its determination, the lack of parallaxes of long period Milky Way Cepheids. We have developed a new technique to measure relative astrometry of bright stars and their parallaxes with WFC3 using spatial scanning, improving upon the previous best relative astrometry with the HST FGS by an order of magnitude to reach distances of 1-4 kiloparsecs. A new scanning mode, serpentine spatial scan, is available in Cycle 21. It allows us to avoid saturating observations of Milky Way

Cepheids with P>25 days which would otherwise be too bright. Measuring the luminosities of these Cepheids is vital to calibrating their analogues visible to HST in distant galaxies which host type Ia supernovae. With Planck CMB data already in hand, this new measurement of the Hubble constant will more than double the precision of the dark energy equation of state, may reveal a new species of neutrino, and would further HST's legacy in the measurement of the Hubble constant, a task for which it was launched.

Proposal Category: SNAP
Scientific Category: Cosmology
ID: 13335
Program Title: HST and Gaia, Light and Distance

Principal Investigator: Adam Riess

PI Institution: The Johns Hopkins University

New, powerful cosmological constraints will become available over the next few years from Planck, DES, BOSS, Pan-STARRS, and HETDEX, at which point the need for a ~1% measurement of the Hubble Constant will be great; it would provide more than the equivalent constraint on dark energy as suddenly doubling all other cosmological datasets, a daunting proposition. An opportunity to reach this goal will occur when the ESA Gaia mission measures percent level parallaxes to hundreds of known Milky Way Cepheids. The most valuable such Cepheids are the known 60 which have long periods like those of the 1000's of extragalactic Cepheids observed by HST in distant galaxies and whose distance and extinction offer the most precise and reliable calibrations of the luminosities of extragalactic Cepheids. HST observations of extragalactic Cepheids in the hosts of recent SNe Ia have been used to calibrate their Hubble diagram which itself provides 0.5% precision for determining the Hubble constant. To retain the exquisite precision of Gaia when using Cepheids to measure the distance to nearby galaxies, it is crucial to have calibrated the Milky Way Cepheid fluxes on the same HST photometric system used for extragalactic Cepheids. We propose a snapshot program to measure these Milky Way Cepheid fluxes with the HST photometric system used for extragalactic Cepheids and which, if completed at the expected 50% level would provide a better than 1% calibration of the distance scale to anchor the best future determination of the Hubble constant and the nature of dark energy.

Proposal Category: GO
Scientific Category: Solar System
ID: 13336
Program Title: Probing Io's putative global magma ocean through FUV auroral spot morphology

Principal Investigator: Lorenz Roth

PI Institution: Southwest Research Institute

Whether Io possesses a magma ocean or not is a central issue for understanding the most volcanically active body in our solar system and is a long standing question as well. Khurana et al., Science 2011, recently substantiated the existence of a highly conductive magma layer inside Io's interior based on Galileo magnetometer measurements and techniques similar to those used to probe the crusts of Europa, Ganymede, and Callisto for liquid water oceans. If a

global magma ocean modifies Io's local magnetic field environment, it will also significantly alter the morphology of Io's UV aurora. The most prominent aurora features are two bright spots that rock around the equator roughly in correlation with the varying orientation of the tilted Jovian magnetic field. Magnetic induction in a magma ocean would stongly attenuate the rocking of these near-surface spots. Interestingly, in previous STIS FUV observations the measured spots locations disagree considerably from the locations theoretically predicted for the global magma ocean case, but are in reasonable agreement if there is no ocean. However, the temporal and orbital coverage of Io's rocking auroral spots for the STIS dataset is presently insufficient to conclusively exclude or further investigate the molten magma layer idea. We therefore propose two visits of five consecutive STIS orbits to trend the auroral spot feature locations over a full variation cycle of the Jovian magnetic field near western elongation. This investigation will decisively constrain the molten magma layer inside Io and tests the putative evidence for a global ocean by Khurana et al. (2011).

Proposal Category:	GO
Scientific Category:	Cosmology
ID:	13337
Program Title:	Resolving the Cluster-Lensed Sextuple Quasar SDSSJ2222+2745
Principal Investigator:	Keren Sharon
PI Institution:	University of Michigan

We propose deep multiband imaging of the newly discovered large separation lensed quasar, SDSSJ2222+2745. This system is only the third known of its kind, and uniquely features the largest observed image multiplicity (at least 6), three known images close to the cluster core, and the highest redshift quasar (z=2.8). The cluster also lenses a galaxy at z=2.3 into a giant arc. With the proposed imaging we will precisely measure the three demagnified images of the quasar close to the center of the cluster, detect the 7th image predicted by the lens model, identify additional lensed galaxies, resolve the star formation in the giant arc and the quasar host, measure an upper limit for the mass of the black hole at the centers of the cluster galaxies, and compute a precise and accurate lens model that will form the foundation of many future studies.

Proposal Category:	GO
Scientific Category:	Extra Solar Planets
ID:	13338
Program Title:	Confirming a Sub-Earth-Sized Exoplanet in the Solar Neighborhood
Principal Investigator:	Kevin Stevenson

PI Institution: University of Chicago

The future of exoplanet characterization is moving towards atmospheric studies of transiting rocky exoplanets. The paucity of nearby candidates suitable for these studies is a pressing issue in the exoplanet community and several current and proposed programs (such as MEarth and TESS) are working towards uncovering these Earth-sized planets. We recently published evidence for at least one new exoplanet candidate in the GJ 436 system. If confirmed, UCF-1.01 would be one of the smallest exoplanets currently detected and, at a distance of only 10.2 pc, it would be the most easily-observable transiting rocky planet outside of the Solar System and part of the first compact system of planets orbiting a nearby M dwarf. The GJ 436 system would become a prime target for follow-up investigations in fields such as interiors, atmospheres, dynamics, and further radial-velocity and transit searches. In order to secure a firm detection, we require the stability and photon-gathering power of the Hubble Space Telescope. With only eight orbits around the Earth, HST is capable of confirming the presence of UCF-1.01 with an unassailable significance of 20 sigma. HST's two visits would obtain good phase coverage of the entire 45-minute transit, confirm consistency in the measured transit depths, and place better constraints on the planet's physical and orbital parameters. No other facility is currently capable of validating this exoplanet candidate and growing uncertainty in the mid-transit time is adding a real urgency to this task. Cycle 21 is now our best opportunity to definitively confirm the existence of the first sub-Earth-sized exoplanet in the solar neighborhood.

Proposal Category: GO

Scientific Category: ISM and Circumstellar Matter

ID: 13339

Program Title: R Aqr: a prototype for non-relativistic astrophysical jets and a key for understanding jet formation

Principal Investigator: Matthias Stute

PI Institution: IAAT, Eberhard Karls University, Tuebingen

R Aqr is a well-known prototype for non-relativistic astrophysical jets. The R Aqr jet has been extensively observed in the ultraviolet, optical, and radio regimes. We propose to re-visit this enigmatic object with HST after twelve years, in order to measure the proper motions of its inner knots with unprecedented accuracy, to derive emission lines ratios for these knots, and to investigate the width of the jet at several distances from the jet source. We will compare the results with numerical models of radiative shocks in propagating jets and of jet formation models and will determine the kinematics of the jet, the history of ejection events and basic parameters of the jet engine as e.g. the launching radius of the jet-ejecting accretion disk.

Proposal Category: GO

Scientific Category: Hot Stars

ID: 13340

Program Title: Detecting a Hot Companion to the Progenitor of the Type Ic Supernova 1994I in M51

Principal Investigator: Schuyler Van Dyk

PI Institution: California Institute of Technology

Core-collapse supernovae (SNe) are the endpoints of the lives of massive stars (with initial mass > 8 solar masses). We are reasonably confident that the progenitor stars for most hydrogen-rich Type II SNe are red supergiants, based in part on direct identifications with HST. However, the progenitors of the stripped-envelope He-rich Type Ib and He-poor Type Ic SNe have yet to be directly identified. These SNe are thought to arise from either single, high-mass stars in the Wolf-Rayet phase or, alternatively, from lower-mass stars in interacting binary systems. Both models can account for the required extensive envelope stripping. Until a progenitor is identified for these SN types, our best hope of testing these progenitor models is to detect the companion star to the progenitor, if the binary model holds. This star is predicted to be a hot supergiant. Therefore, it is best detected in the ultraviolet. The only SN which is sufficiently nearby and experienced low enough reddening to be a viable target for this detection is the SN Ic 1994I in M51. Furthermore, the SN was imaged by HST when it was still bright, so we can pinpoint its location. We therefore propose, as part of the UV Initiative in Cycle 21, to image the site in F275W and F336W to levels deep enough to significantly detect a putative progenitor companion, if it exists. The proposed observations will provide an important test of the binary progenitor hypothesis.

Proposal Category: GO

Scientific Category: Resolved Stellar Populations

ID: 13341

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 recently 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 6100 known SNe, we know relatively little about the stars which give rise to these powerful explosions. The main limitation has been the lack of spatial resolution in pre-SN imaging data. However, since 1999 our team has been at the vanguard of directly identifying SN progenitor stars in HST images. From this exciting line of study, the emerging trend from 9 detections for Type II-Plateau SNe is that their progenitors appear to be relatively low mass (8 to 20 Msun) red supergiants, although more cases are needed. Additionally, evidence is growing 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 currently being used for precision cosmology. In Cycles 16 and 17 we had great success with our approved ToO programs. As of this proposal deadline, we had not yet triggered our Cycle 20 program. We therefore propose to continue this project to determine the identities of the progenitors of 4 SNe within, generally, about 20 Mpc, which we expect to occur during Cycle 21, through ToO observations using WFC3/UVIS.

Proposal Category: GO
Scientific Category: Cosmology
ID: 13342
Program Title: Warm And Hot Gases In And Around Cluster Galaxies At Z=0.1-0.2

Principal Investigator: Q. Wang

PI Institution: University of Massachusetts - Amherst

We propose a joint HST/XMM-Newton observing program to study both warm and hot gases in three optically-selected galaxy clusters at z=0.117-0.2108. Each cluster has a UV-bright background QSO projected within the expected strong accretion shock (< 2r_200). We will observe UV absorption lines of the O VI doublet, HI Ly-alpha and Ly-beta, and other ion transitions in the rest frame of the clusters, using the HST/COS G130M grating. These absorption lines are sensitive to the thermal, kinetic, and chemical properties of warm (T < 10^6 K) gas, associated with the halos of individual galaxies and the intracluster medium. Chandra/ACIS observations will be used to measure the luminosity, temperature, and morphology of the hot gas component of the clusters, especially in their core regions. This joint study will thus allow us for the first time to characterize the heating/cooling and dynamic processes of these multiple gas phases in the clusters. The understanding of these processes is essential for understanding cluster galaxy evolution, the correct interpretation of X-ray and Sunyaev-Zeldovich effect measurements, and the use of clusters as cosmology probes.

Proposal Category: GO
Scientific Category: Cosmology
ID: 13343
Program Title: Probing Dark Matter with a New Class of Merging Clusters

Principal Investigator: David Wittman

PI Institution: University of California - Davis

We request multiband imaging in support of a weak lensing analysis of a new radio-selected sample of merging galaxy clusters. After first pericenter passage, merging clusters exhibit a dissociation between gas (which remains in the center of the system due to its collisional nature) and galaxies and dark matter (which are collisionless or nearly so, and continue outbound). Self-interaction of dark matter (DM) will cause the DM to lag the galaxies slightly. Weak lensing analyses with the proposed imaging (using multiband photometry to exclude foreground and cluster member galaxies) will yield measurements of the DM-galaxy offset accurate to ~5", sufficient to test current suggestions that the self-interaction cross section of dark matter may be in the range 0.1-0.5 cm2/gm. Only HST can provide this level of weak lensing precision.

Other merging systems are being studied with similar goals in mind, but this sample is unique in being radio-selected. The "radio relics" represent shocks which are vital in constraining the dynamics of the systems; only a few other mergers have clear evidence of shocks. A further key strength of this proposal is the ensemble approach: each system's unique set of dynamical properties (merger velocity, time since pericenter, etc) provides a unique test of the self-interacting DM (SIDM) hypothesis, so the constraints from the ensemble are powerful. We will derive constraints

from the ensemble of these three clusters plus the Musket Ball Cluster (observed by us in a previous cycle), which shows a DM-galaxy offset at a level detectable only by HST.

Proposal Category:	GO
Scientific Category:	Unresolved Stellar Populations
ID:	13345
Program Title:	Determining the Progenitor of SN2011dh as a Test of Supernova Shock Cooling Models
Principal Investigator:	Iair Arcavi
PI Institution:	Weizmann Institute of Science

Connecting pre-supernova stellar parameters of massive stars to core collapse supernova (SN) properties is crucial for our understanding of the explosion physics and for constraining the final stellar evolutionary stages of massive stars. There are currently two leading observational methods for obtaining properties of SN progenitors: pre-explosion high resolution images and early-time shock-cooling observations of SNe. Both methods were applied to SN 2011dh with possibly conflicting results. The pre-explosion images suggest a supergiant progenitor, while the early post-explosion data possibly point towards a compact progenitor. Now that the SN has faded, HST observations of the explosion site can settle this discrepancy. By obtaining post-explosion images in the same instrument and filters as the existing pre-explosion images, we will be able to determine whether the suggested supergiant source is indeed the SN progenitor, and if not, to derive the SED of the true progenitor. This data, which can be obtained in a single HST orbit, will serve as a crucial direct test of shock cooling models. We recognize that this object is of great importance to the community and therefore we request only a minimal proprietary period of three months.

Proposal Category:	GO
Scientific Category:	Hot Stars
ID:	13346
Program Title:	Advanced Spectral Library II: Hot Stars
Principal Investigator:	Thomas Ayres
PI Institution:	University of Colorado at Boulder

Stars are the bright matter of the Universe. Without them, it would be a dull and dreary place indeed: no light, no heavy elements, no planets, no life. It also is safe to say that stellar spectroscopy is a cornerstone of astrophysics, providing much of what we know concerning temperatures and masses of stars, their compositions, planets, and the dynamics and evolution of the galaxies they inhabit. This is especially true for the satellite ultraviolet, owing to the rich collection of atomic and ionic transitions found there. Unfortunately, the archive of Space Telescope Imaging Spectrograph rarely achieves the high S/N of the best ground-based spectra, and relatively few objects have the full wavelength coverage for which the powerful, highly multiplexed, second generation Hubble instrument was designed. Our aim is to collect STIS UV echelle spectra -- comparable in S/N and resolution to the best ground-based material -- for a diverse sample of representative stars, to build an Advanced Spectral Library; a foundation for astrophysical exploration: stellar,

interstellar, and beyond. Our first effort, in Cycle 18, involved cool stars. Now we turn attention to the hot side of the H-R diagram.

Our Treasury program will provide detailed stellar "atlases," based on advanced processing of the STIS echellegrams. Members of our broad collaboration will analyze these data for specific purposes, such as dynamics of O-star mass-loss; detection of rare species in sharp-lined B stars; and properties and kinematics of local interstellar clouds; but public release (based on the "ASTRAL" model) will enable many other investigations by a much wider community, for decades to come.

Proposal Category: GO
Scientific Category: ISM in External Galaxies
ID: 13347
Program Title: The Missing Baryons Around Nearby Dwarf Galaxies

Principal Investigator: Joel Bregman
PI Institution: University of Michigan

Dwarf galaxies are missing nearly all of their baryons, which have presumably flowed away as a wind. This mass loss accounts for a significant fraction of all baryons lost from galaxies, so there is great interest in determining the size and scope of the gas lost. This gas is not visible in emission but is detectable through absorption features toward background AGNs. Here we propose to observe the absorbing material around three isolated dwarfs on the periphery of the Local Group: Sextans A, Sextans B, and NGC 3109. Unlike more distant dwarfs, the star formation history and cold gaseous content of these galaxies are well-studied. The isolation of these dwarfs, far from large galaxies, means that they have not yet interacted with other systems so their mass loss history is well-preserved, making them ideal targets for study.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13348
Program Title: Imaging the Crab nebula when it is flaring in gamma-rays

Principal Investigator: Andrea De Luca
PI Institution: INAF, Instituto di Astrofisica Spaziale e Fisica

One of the most intriguing results of the gamma-ray instruments currently in orbit has been the detection of powerful flares from the Crab Nebula. Such events, detected roughly once per year, can be very spectacular. Indeed, in April 2011, for a few days the Crab was by far the brightest source in the gamma-ray sky. Such a dramatic variability challenges our understanding of how pulsar wind nebulae work and defies current astrophysical models for particle

acceleration. With the aim of locating the site(s) of the flares, an ad hoc HST strategy must be put in place to be prepared and react promptly in case of a new brightening in gamma rays. We ask here for a triggered TOO observation of the Crab Nebula with ACS/WFC in case a gamma-ray flare is announced by the Agile and/or Fermi missions. This is a crucial part of a multiwavelength program that we are organizing, based on lessons learnt from our follow-up observations of previous flares, including a regular (monthly) monitoring of the source both in X-ray and optical through a joint Chandra-HST proposal.

Proposal Category: GO
Scientific Category: Cosmology
ID: 13349
Program Title: Escaping Lyman Continuum in Strongly Lensed Galaxies at z=2.0-2.5

Principal Investigator: Xiaohui Fan

PI Institution: University of Arizona

We propose to obtain deep WFC3 UVIS channel near ultraviolet (NUV) images of a sample of 10 bright lensed galaxies at z = 2.0 - 2.5 to detect the escaping Lyman continuum (LyC) radiation in order to study the physical properties of the LyC emitting region and the evolution of ionizing photon escape fraction with redshift. The LyC escape fraction is a key parameter in determining the contribution of star-forming galaxies to UV ionization background and to the cosmic reionization. It is, however, poorly constrained with conflicting results. In this proposal, we will use the observations of the brightest lensed galaxies (r<21.0) to provide accurate measurement of escape fraction in high-redshift galaxies, sensitive to the flux ratio between intergalactic medium corrected LyC and 1500A of as low as 0.5-3% in individual galaxies, and 0.2% when stacking all galaxies. In addition, lensing effect will allow us to probe a wide range of intrinsic luminosity (-20.5<M_UV<-23.5, 0.6L*-10L*), and the highly stretched images provide a high spatial resolution to study of the detailed LyC escape geometry. We will correlate LyC properties with physical properties of the lensed galaxies provided by existing deep HST imaging and ground-based near-IR spectroscopy to constrain physical models of LyC escape mechanism. Our sample will also fill the gap of the redshift range between 2.0 - 2.5 that has not been probed in previous works, allowing study of the evolution of escape fraction in the redshift range of z = 1 to 3.5.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13350
Program Title: How Low Can They Go? Detecting low luminosity supernova progenitors

Principal Investigator: Andrew Fruchter

PI Institution: Space Telescope Science Institute

While we now discover thousands of supernovae (SNe) per year, in the history of astronomy a little more than a dozen SN progenitors have been identified, and all of these have been from Type II SNe. This dearth is largely due to the fact that the progenitors are destroyed in the SN, and so to study them one must have fortuitously taken data on them prior to their explosion. However, the fault may also partially lie with the methods employed to search for progenitors.

In the past, searches have generally relied on looking at the location of a SNe in an archival image to see if a noticeable point source is at the right location. This method requires that the background field of the galaxy be relatively uniform, and if one wants an accurate estimate of the progenitor mangitude, that the star was not in an association or binary. Here we propose to take WFC3 images several years post explosion so that we can subtract them from archival WFPC2 images. We show that we can do this with extraordinary fidelity. We will apply this method to a well-chosen sample of three Type II SNe and two Type Ibc SNe, which lie on messy galaxy fields that may have camouflaged the presence of a progenitor. This method has the potential to detect or substantially deepen the limits on the progenitors of these objects, which already appear too faint for theoretical models.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13351
Program Title: UV Spectroscopy of a Peculiar White Dwarf Supernova

Principal Investigator: Saurabh Jha

PI Institution: Rutgers the State University of New Jersey

While type Ia supernovae (SNe Ia) have been extremely useful for studying the cosmic expansion history, their explosion mechanism and progenitor system remain unsolved problems. Moreover, as large samples of SNe are observed, the diversity among these explosions has grown: not all exploding white dwarfs look like normal SNe Ia. Understanding why these "peculiar" objects are different from the normal ones can help explain the standard SN Ia scenario, as well as give us a better understanding of the many endpoints of stellar evolution. Connecting observations to physical models has been difficult for both normal and peculiar white dwarf supernovae. The ultraviolet is a largely unexplored wavelength region for peculiar SNe Ia; the high opacity in the UV from typical thermonuclear burning products means that the UV flux in white dwarf supernovae is very sensitive to the outermost layers of ejecta. This material is the least processed, and is thus an ideal place to look for clues to progenitors and explosion mechanisms. Here we propose to take advantage of the Cycle 21 UV Initiative to obtain target-of-opportunity STIS UV spectroscopy of a peculiar white dwarf supernova to add a unique piece of the puzzle connecting peculiar SNe Ia and their progenitors.

Proposal Category: GO
Scientific Category: Cosmology
ID: 13352

Program Title: WFC3 Infrared Spectroscopic Parallel Survey WISP: A Survey of Star Formation Across Cosmic Time

Principal Investigator: Matthew Malkan

PI Institution: University of California - Los Angeles

Our WFC3 Infrared Spectroscopic Parallels (WISPs) have shown the power of slitless spectroscopy to probe galaxy evolution from 0.5<z<2.5. WISP is particularly sensitive to low-mass, metal-poor, galaxies with extreme star formation rates. These are missed by conventional continuum-selected surveys. The broad, continuous, spectral coverage of the G102 and G141 grisms (0.8--1.7 um) provides the best measurement of the de-reddened star formation rate, and the mass-metallicity relation, throughout this epoch, over which ground-based searches are severely limited.
We propose to extend this cost-effective WFC3 Survey by using 375 pure parallel orbits for grism spectroscopy in 50 deep (4-5 orbit) and 50 shallow (3-orbit) fields. This will complete a sample of 6000 galaxies with [OII], [OIII], Ha, Hb, or [SII] in the redshift desert. Our primary science goals are: (1) Derive the extinction-corrected Ha luminosity function, and the resulting 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 low masses, with the support of our ongoing ground-based follow-up. (3) Examine the role of metal-poor dwarfs and extreme starbursts in galaxy assembly. (4) Use the Balmer break and D4000 diagnostics to find and determine the ages of absorption-line galaxies down to J=24-25. (5) Search for rare objects such as Lya emitters at z>6, reddened AGN, close physical pairs of galaxies, T- and Y-dwarf stars (of which we have already found three).
The WISP value-added public data release is likely to be one of Hubble's major legacies of 0.8--1.7 um spectroscopy.

Proposal Category: GO

Scientific Category: Hot Stars

ID: 13353

Program Title: Flux calibration of the COS FUV modes

Principal Investigator: Derck Massa

PI Institution: Space Science Institute

We intend to use a model atmosphere for the DB white dwarf WD0308-565 to calibrate COS below 1150 Ang. This model has been vetted at longer wavelengths, where it has been shown to agree with previous DA calibrations. However, unlike the DA standards, WD0309-565 contains very little hydrogen. This eliminates uncertainties in the physics of the Lyman stark wings which affect virtually all wavelengths below 1100 Ang. As a result, it will provide a superior, less biased calibration for COS at these wavelengths. These same data will be used to produce fixed pattern templates for the new COS FUV settings. These can be used to reduce the effects of the COS fixed pattern noise.

Proposal Category: GO
Scientific Category: Cool Stars
ID: 13354
Program Title: COS Spectroscopy of White Dwarf Companions to Blue Stragglers in NGC 188

Principal Investigator: Robert Mathieu

PI Institution: University of Wisconsin - Madison

Mass transfer in binary stars yields SNe Ia events, X-ray binaries, CVs, and a host of stellar exotica that in fact are frequent and crucial for understanding the Universe. Mass transfer is a critical astrophysical process.

Key uncertainties remain in mass transfer theory: criteria for stable transfer, when transfer is conservative, impact of orbital eccentricity. Empirically determined conditions both before and after mass transfer will advance answers to these issues. Yet there are very few systems with detailed knowledge of the progenitor binaries.

We propose COS Lyman-alpha spectra of two mass transfer systems, both well-studied blue straggler binaries in the 7-Gyr cluster NGC 188, so as to obtain direct mass measurements of their white dwarf companions.

Our recent ACS/SBC photometry discovered these white dwarf companions to have temperatures greater than 15,000K, implying WD ages less than 140 Myr. Mass transfer has only very recently ended. As evolved stars at 7 Gyr, the progenitor donor stars had initial masses of 1.1 solar masses.

The white dwarfs are the cores of these progenitor donor stars at 7 Gyr. Measurements of their masses can for the first time point to the location of each progenitor donor star on its stellar evolution path at the end of mass transfer, and thereby along a timeline during the mass transfer.

White dwarf masses from COS spectra and rich existing data will provide a remarkably detailed description of these blue

Proposal Category: GO
Scientific Category: Cool Stars
ID: 13355
Program Title: Uncovering the Nature of the Evolving Remnant Star of a Recent Stellar Merger

Principal Investigator: Bruce McCollum

PI Institution: Catholic University of America

The 2008 nova of V1309 Sco has been determined to have resulted from a stellar merger between a K giant and a late-type dwarf. This is the first stellar merger ever to be observed during and soon after the event. Mergers are thought to be a significant influence in the evolution of both open and globular clusters as well as the centers of spiral galaxies, but mergers remain a poorly-understood phenomenon because there has been no opportunity before now to study one in progress. No spectra in visible light have been published of the remnant star of V1309 Sco except for a few spectra obtained several months after the merger. Those spectra showed that the merger remnant had many strong emission lines, some of which were anomalous, and that the remnant was evolving dramatically in spectral type. It is important to continue to study the remnant spectroscopically because the merger process and its aftermath are poorly understood. The exact nature of the star which the remnant will become is not known or even theoretically predicted. Visible-light spectra will let us determine the current apparent spectral type. N-body merger models, as well as infrared observations we have obtained after the event, suggest that considerable mass was lost during the merger. Visible-light spectra will help us to learn how much mass was lost, and will help us look for possible identifying clues which could be used to determine whether other novae might have resulted from mergers.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13356
Program Title: A Candidate Gravitationally Lensed Quasar at z=6.09

Principal Investigator: Ian McGreer
PI Institution: University of Arizona

We have obtained WFC3/IR images of nearly half of the known quasars at z~6 through a Cycle 18 SNAP program. During the latter part of the Cycle we identified a candidate gravitationally lensed quasar, SDSSJ1602+4228, at z=6.09. The short duration SNAP exposure shows that the central arcsecond is resolved into multiple emission features, which we interpret as two lensed images of the z=6 quasar and the lens galaxy. However, from the single band image the nature of the components is inconclusive. We propose a brief (two orbit) follow-up program that will include imaging in three bands: WFC3/IR Y and H, and ACS/WFC r-band. The combination of infrared and optical imaging will allow us to use color information to isolate the quasar images, lens galaxy, or any contaminating foreground objects. The confirmation of even one lensed quasar among the SNAP sample has strong implications for the shape of the quasar luminosity function at z=6, with further implications for expected source counts at higher redshift, as well as models for black hole growth in the early Universe.

Proposal Category: GO
Scientific Category: Cosmology
ID: 13357
Program Title: Feeding Galaxies: Cold Accretion Through Warps

Principal Investigator: David Radburn-Smith
PI Institution: University of Washington

The question of how gas in the diffuse IGM transfers into galaxy disks has become one of the main observational challenges of the LCDM paradigm. Observations have yet to conclusively reveal this gas accretion and so cannot explain the high star-formation rates found in the local Universe. Modeling suggests that infalling gas, which is often misaligned with the angular momentum of the galaxy disk, will form a warped outer gaseous disk. However, such accretion events are not the only possible explanation of these warps. They may also form through gravitational torques, which could, for example, arise through tidal interactions or misalignments between the disk and dark-matter halo.

Fortunately, resolved stellar populations in the gas warps of nearby galaxies can discriminate between the different mechanisms for forming warps. Specifically, the models differ in their distribution and metallicity of old stars. If we do

observe the predicted stellar populations due to accretion, then this will directly reveal the ongoing gas fueling of galaxy disks.

We thus propose to use ACS and WFC3 in parallel to study the resolved stellar populations in all nearby warped galaxies as selected from the largest sample of such edge-on systems. Using our previous experience with deep color-magnitude diagrams from HST, we will comprehensively explore age and metallicity distributions of stars both in and outside the warp. We will compare these distributions with simulations covering a similar mass range in order to study the underlying formation mechanisms. This unique method directly addresses the issue of sufficiently fuelling the current star formation rate observed in the local Universe.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13358
Program Title: Trans-iron group elements in the hot white dwarf RE 0503-289

Principal Investigator: Klaus Werner
PI Institution: Eberhard Karls Universitat, Tubingen

We propose STIS-UV spectroscopy of the rather peculiar, hot helium-rich white dwarf RE 0503-289. In FUSE spectra we have recently discovered as much as ten trans-iron group elements (atomic numbers between 31-54), a phenomenon that has never been observed before in any WD. Abundance analyses of Kr, Xe, and Ge show that they are strongly overabundant (450 to 3800 times solar). We suspect that this is related to the evolutionary history of the WD. RE 0503-289 is a transition object between the PG1159 and DO spectral classes, which represent a (pre-) WD sequence of stars that suffered a late He-shell flash. As a consequence of flash-induced envelope convection, the WD exposes the H-He intershell layer of the progenitor AGB star that is enriched with trans-Fe elements resulting from s-process nucleosynthesis. The proposed UV observations shall support a precise abundance analysis of all other elements detected so far, but we mainly aim at the detection and analysis of hitherto undetected heavy elements. We want to address the question whether the observed abundance pattern is affected by diffusion or if it represents the original composition of the s-processed material. In the latter case, detailed tests of nucleosynthesis models are possible.

Proposal Category: GO
Scientific Category: ISM in External Galaxies
ID: 13361
Program Title: Discovering and Characterizing the Young Supernova Remnant Population in M101

Principal Investigator: William Blair
PI Institution: The Johns Hopkins University

Young supernova remnants (SNRs), especially ones like Cas A where heavy elements are still prominent, provide insights into SNe, the stars that produce them, and the galaxies where they reside. Here we propose to leverage and expand on existing Hubble ACS/WFC images of the iconic face-on spiral M101 by obtaining new [O III] data and [S II] images to identify and characterize the SNR population of M101. Deep H-alpha images of M101 already exist for 4 ACS

fields, as does an extremely deep (1 Ms Chandra) X-ray study--important since many SNRs, including ALL of the known ejecta-dominated ones, are strong X-ray sources. While existing data have enabled exploration of SNRs previously identified from the ground, they do not allow identifications of new (and especially young) SNRs. We propose to observe these fields in [O III] (strongest line in ejecta-dominated SNRs) and [S II] (to provide the S II]/H-alpha ratio diagnostic to distinguish SNRs from photoionized nebulae), plus adding one new field in these lines plus H-alpha. For a modest time investment, all the optical and X-ray diagnostics will be in hand to explore what we expect to be a rich population of young SNRs in the complex inner regions of the galaxy where HST resolution is most needed. Furthermore, ACS images in BVI also exist for these fields, so we will use CMD fitting to constrain the progenitor masses for many of these as we did for the SN 1957D remnant in M83. We will compare to other galaxies, especially M83 where the young SNRs appear to have evolved quickly beyond the ejecta-dominated stage. M101 and M83 differ in mean abundances and star formation rate areal density, providing contrasting conditions.

Proposal Category:	GO
Scientific Category:	Debris Disks
ID:	13362
Program Title:	Constraining the structure of the Kappa Cr B planetary system, a unique subgiant, orbited by two companions and a debris disc
Principal Investigator:	Amy Bonsor
PI Institution:	Institute de Planetologie et d'Astrophyisque de Grenoble

We propose to use STIS to image, in scattered light, the debris disc orbiting the subgiant, kappa CrB, a multi-planet-hosting, 'retired' A star. Recently our Herschel imaging of the debris disc orbiting kappa Cr B, provided the first resolved images of a debris disc orbiting an evolved star. In addition, radial velocity observations have found two companions to this star, one giant planet with m sin I = 2.1MJ and a=2.8AU and a second companion, whose orbital parameters are poorly constrained. Modelling of the Herschel data was unable to distinguish between two possible distributions for the dust, one where it is distributed in a single wide belt and one in which it is split into two narrower rings. The increased angular resolution of HST will be used to determine the radial distribution of the dusty material in this planetary system, distinguishing between the two proposed scenarios, probing interactions between the planet(s) and the disc and further constraining the orbit of the second companion. In summary, Kappa CrB is a unique example of an intermediate mass star, evolved beyond the main-sequence and orbited by both planets and a debris disc, from which we can learn about the structure of planetary systems around intermediate mass stars, as well as probing their evolution beyond the main-sequence.

Proposal Category:	GO
Scientific Category:	Unresolved Star Formation
ID:	13363
Program Title:	Gauging dust settling in 5-10 Myr old disks with COS
Principal Investigator:	Nuria Calvet

PI Institution: University of Michigan

We propose to carry out observations with COS of the FUV emission in 7 disks in the Orion OB1b and 1a subassociacions, with ages ~5 and ~ 10 Myr respectively, the age range where disks are actively evolving and dissipating. Our observations will increase by a factor of ~3 the number of disks observed with COS in this critical age range, and encompass the goals of the Ultraviolet Initiative of Cycle 21. The H2 lines excited by Ly alpha present in the COS spectra of our targets, in combination with our ground-based and Spitzer observations, will allow us to estimate the amount of dust settling of the inner disk, providing us with unprescedented insight into the state of evolution of these mature disks.

Proposal Category: GO

Scientific Category: Unresolved Star Formation

ID: 13364

Program Title: LEGUS: Legacy ExtraGalactic UV Survey

Principal Investigator: Daniela Calzetti

PI Institution: University of Massachusetts - Amherst

We propose to build the first HST UV Atlas of 51 nearby star-forming galaxies, carefully selected to span the full range of morphology, star formation rate (SFR), mass, metallicity, internal structure, and interaction state found in the local Universe. In combination with archival and new optical (UBVI) WFC3/ACS data, the requested WFC3/UV images are key for deriving accurate recent (<50 Myr) star formation histories (SFHs) from resolved massive stars, and the extinction-free ages and masses of star clusters and associations. These extensive inventories of massive stars, clustered systems, and SFHs will be used to: (1) quantify how the clustering of star formation evolves both in space and in time; (2) discriminate among models of star cluster evolution; (3) investigate the effects of SFH on the UV SFR calibrations; (4) explore the impact of environment on star formation and cluster evolution across the full range of galactic and ISM properties. These are only a few of the science opportunities enabled by LEGUS. The astronomical community will add many more: LEGUS observations will inform theories of star formation and galaxy evolution, and improve the understanding of the physical underpinning of the gas-star formation relation and the nature of the clumpy star formation at high redshift. LEGUS will generate the most homogeneous high-resolution, wide-field UV dataset to date, building and expanding on the GALEX legacy. LEGUS will populate the HST Archive with unique data, that will be ready for immediate use by the community through the extensive data products we will deliver, and will provide a unique foundation for future observations with JWST and ALMA.

Proposal Category: GO

Scientific Category: ISM and Circumstellar Matter

ID: 13365

Program Title: Probing the nature of small-scale structure towards rho Oph stars: A new avenue in diffuse interstellar band research

Principal Investigator: Martin Cordiner

PI Institution: NASA Goddard Space Flight Center

The first evidence for variations in diffuse interstellar band (DIB) strengths over distance scales as small as a few hundred AU was presented by Cordiner et al. (2013), who measured diferences of 5% - 9% in the equivalent widths of several DIBs between the close binary stars rho Oph A and B (separated by c. 344 AU). Larger differences were observed between AB and rho Oph D (separation 19,000 AU), indicative of substantial small-scale variations in the abundances of the large molecules believed to cause the DIBs. This finding offers an unprecedented opportunity to examine the factors that control diffuse band strengths in the relatively small and controlled environment of rho Oph, in order to help resolve the 92-year-old mystery of the identities of the carriers. A secondary objective is to measure the properties of the gas responsible for small-scale structure towards rho Oph, and ascertain the cause of previously-observed atomic and molecular absorption line strength variations. This will provide important information on the nature of diffuse molecular gas in a star-forming region, of relevance to theories regarding molecular cloud formation. We propose to achieve these goals through very high-sensitivity measurements of the ionisation state, temperature, density and depletion of the interstellar gases in the sightlines towards rho Oph A, B and D through high-signal-to-noise, high-resolution observations of atoms, ions and molecules at wavelengths 117-240 nm. Primary diagnostics include the relatively-unsaturated absorption lines of C I, Fe I, Fe II and C2.

Proposal Category: GO

Scientific Category: Resolved Stellar Populations

ID: 13366

Program Title: The vertical disk structure of spiral galaxies and the origin of their thick disks

Principal Investigator: Roelof de Jong

PI Institution: Astrophysikalisches Institut Potsdam

Our knowledge of the formation and evolution of the main galactic components (bulge, disks, halo) has vastly increased in recent years, but especially the formation of thin and thick disks in spiral galaxies are still poorly understood. Despite the large of number of galaxies for which the structural parameters of thin and thick disks have been measured, and the increasing amount of data about the Milky Way's disks, there is no consensus on the mechanism that drive the formation and evolution of thick disk components.

Thick disk formation models can be classified in three categories: 1) the thick disk is created in situ as a hot component from merging turbulent gas clouds at high redshift, 2) an original thin disk created from cold gas is heated by one or more dynamical processes (scattering off spiral arms, bars, molecular clouds in both vertical and radial direction, merger events, bombardment by dark matter subhalos), and 3) the thick disk consists of the remnants of accreted satellite galaxies. Each of these models is expected to leave distinct signatures in the radial and vertical distribution of stars of different ages.

Here we propose to use the unique HST capabilities to resolve the stellar disk contents of three nearby massive edge-on disk galaxies using ACS and WFC3 imaging. Resolving stellar populations in both vertical and radial direction allows us to disentangle stars of different ages and to measure their disk parameters separately. We can thus quantify the temporal evolution of scaleheights and scalelengths, and the amount of flaring in these galaxies, which will enable us to give definitive verdicts on the various thick disk formation scenarios.

Proposal Category: GO
Scientific Category: ISM in External Galaxies
ID: 13367
Program Title: UV Line Emission from Million Degree Gas in a Galaxy Cluster Core

Principal Investigator: Megan Donahue

PI Institution: Michigan State University

Progress in understanding the nature of galaxy formation and feedback in massive halos depends critically on knowing whether the source of the star-forming gas in Brightest Cluster Galaxies is cooling and condensation out of the hot ambient medium or whether it enters the central galaxy already in cold form. We will study UV and optical line emission from the knots of a powerful star-forming brightest cluster galaxy from the CLASH MCT cluster sample in order to place definitive limits on the presence of intermediate temperature (10^5-6 K) gas in the center of a massive galaxy that is forming stars at ~100 solar masses per year. We have chosen a galaxy cluster at z~0.35 to enable the first ever simultaneous measurement of O VI, N V, and C IV from a cluster core. We will compare the observed UV line ratios to those predicted by competing model for steady nonequilibrium cooling, thermal conduction, and cooling mediated by turbulent mixing.

Proposal Category: GO
Scientific Category: Cool Stars
ID: 13368
Program Title: A Precision Measurement of the Mass of the Cepheid V350 Sgr

Principal Investigator: Nancy Evans

PI Institution: Smithsonian Institution Astrophysical Observatory

An important HST UV legacy is the measurement of the masses of Cepheids. HST has provided double-lined spectroscopic binaries since the orbital velocity amplitude of hot companions can be measured on high resolution ultraviolet spectra. STIS UV E140H echelle observations of the Cepheid V350 Sgr will yield a dramatic improvement in the precision of its mass (5% or 0.25 solar masses vs the current 17%). This will allow a unique and critical test of the role of convective overshoot in the evolution of intermediate mass stars, by coupling the measured mass with a luminosity. Furthermore, the very accurate masses (1-2%) recently determined for two Cepheids in eclipsing binaries in the LMC mean the mass--luminosity relation for Cepheids can be compared for two metallicities. This will improve both confidence in the use of Cepheids as primary extragalactic distance indicators

and also our understanding of the evolution of intermediate mass stars.

Proposal Category: GO
Scientific Category: Cool Stars
ID: 13369
Program Title: The Dynamical Mass of Polaris, the Nearest Cepheid

Principal Investigator: Nancy Evans

PI Institution: Smithsonian Institution Astrophysical Observatory

Cepheid variables are the primary standard candles for measuring extragalactic distances, and they provide critical tests of stellar-evolution theory. Thus it is important to understand them astrophysically. Polaris (alpha UMi) is the nearest and brightest of all Cepheids. It offers a unique opportunity to measure the dynamical mass of a Cepheid, because it is in a 30-year binary system for which a single-lined spectroscopic orbit is already available. In Cycle 14, we resolved the system for the first time, using ACS/HRC in the UV, and followed up in Cycle 15. These observations established the sense of the orbital motion, as well as a first approximation to the dynamical mass. An observation with WFC3 in Cycle 17 again revealed the companion, in spite of the larger pixels than ACS/HRC, after deconvolution. This further refined our mass determination.

We propose an additional WFC3 observation in Cycle 21, which will extend the coverage of the orbit substantially. We estimate that this new observation will reduce the uncertainty in the mass of Polaris from 26% to 10%. The window for this observation is rapidly closing since the two stars are heading for periastron. This is a UV Initiative proposal since making the observations in the UV enhances the relative brightness of the companion, which is warmer than Polaris, by about 2 magnitudes relative to the visible. Because of the degradation of the PSF in short WFC3 exposures due to "shutter jitter," we also request one orbit to observe a nearby bright single star, Beta Cas, using identical exposure times, to serve as a PSF reference star in the specialized FQ232N filter that we will use.

Proposal Category: GO
Scientific Category: Unresolved Stellar Populations
ID: 13370
Program Title: The Formation History of UGC 12591 - the Most Massive Known Field S0 Galaxy

Principal Investigator: Iskren Georgiev

PI Institution: European Space Agency - ESTEC

We propose to determine the formation history of UGC12591 - the most massive known field S0 galaxy in the nearby Universe (D ~ 98Mpc). Its maximum rotational velocity of 483 km/s yields a dynamical mass within 50 kpc of 2x10^12 solar masses. Given its field location, this poses the question of how such a massive bulge can grow in isolation? To trace the UGC12591 star formation and assembly history we will use the properties of its globular clusters (GCs) and massive compact stellar systems which are expected in huge numbers given its mass. In particular, GCs are well known to be among the best indicators of major (merger) galaxy formation episodes, capturing the physical conditions at the time of their formation. With the wide spectral coverage of the proposed obesrvations, we will 1) search for multiple/intermediate-age GC populations and 2) measure whether the specific frequency of the metal-rich GCs relative to the bulge luminosity is enhanced. If any of these points are confirmed, this would strongly favor a merger-driven

(gas-rich) as opposed to "passive" bulge growth (secular evolution). The only possible way to derive robust photometric GC ages and metallicities at the distance of UGC12591 in a reasonable amount of time is by employing the efficiency of HST/WFC3 and the age-metallicity sensitive V, I, H filter combination (F606W, F814W, F160W). In four orbits we will observe the brighter half of the GC population of UGC12591, which will enable us to derive GC population peak age and metallicity (+/- 20%).
The results from this proposal will offer an important leap forward in our understanding of the assembly history of extremely massive isolated S0 galaxies.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13371
Program Title: HST/WFC3 UVIS Imaging of Tidal Disruption Event PS1-10jh

Principal Investigator: Suvi Gezari
PI Institution: University of Maryland

We propose for HST/WFC3 UVIS imaging of tidal disruption event candidate PS1-10jh, a UV/optical transient which is currently the most convincing example of an accretion-powered flare from the tidal disruption of a star by an otherwise dormant supermassive black hole. The proposed observations will critically test the tidal disruption event scenario, provide essential information for modeling the parameters of the event, and constrain theoretical models for the evolution of the accreting debris disk, by 1) determining the flare-nucleus separation much more accurately than ground-based observations, 2) measuring the late-time NUV emission from the flare, and 3) obtaining more accurate independent constraints on the central black hole mass.

Proposal Category: GO
Scientific Category: Unresolved Star Formation
ID: 13372
Program Title: Mapping the magnetospheric structure at outburst of the pre-main sequence close binary AK Sco

Principal Investigator: Ana Gomez De Castro
PI Institution: Universidad Complutense

Pre-main sequence (PMS) binaries are surrounded by circumbinary disks from which matter falls onto both components. The material dragged from the circumbinary disk flows onto each star through independent streams channelled by the variable gravitational field. The action of the bar-like potential is most prominent in high eccentricity systems made of two equal mass stars. AK Sco is a unique PMS system composed of two F5 stars that get as close as 11.3 stellar radii

at periastron (e=0.47). AK Sco is an ideal laboratory to study matter infall in binaries and its role in orbit circularization. Our team has reported recently, the discovery of an unexpected 1.3mHz ultra low frequency (ULF) oscillation in the ultraviolet light curve at periastron passage. The oscillation lasted ~0.6% of the orbital period. According to our numerical simulations, the cirscumstellar structures get in contact at periastron producing an accretion outburst that triggered of the oscillation. If confirmed, this would unveil a new mechanism for angular momentum loss during pre-main sequence evolution and a new type of interacting binary. The objective of this project is to identify the source of the oscillation and the physical structure of the accretion flow before, during and after the oscillation is triggered. Since the accretion flow radiates in the ultraviolet range, this study requires an ultraviolet (UV) spectroscopic monitoring.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13373
Program Title: The changing wind structure of the WR/LBV star in HD 5980

Principal Investigator: Gloria Koenigsberger

PI Institution: Universidad Nacional Autonoma de Mexico (UNAM)

HD 5980 is an extraordinary system of massive stars that is located in the Small Magellanic Cloud. It contains an eclipsing binary (P=19.3 d) consisting of a luminous blue variable (LBV) and its Wolf-Rayet (WR) companion. The LBV underwent a major eruptive event in 1994 during which its bolometric luminosity increased by a factor of ~5 and it is currently approaching its minimum state of activity. The primary objective of this proposal is to determine the wind velocity and mass-loss rate of the LBV in its current state. With these observations and our earlier observations and analyses, HD 5980 offers the unprecedented opportunity of deriving all the fundamental parameters of an LBV system throughout its activity cycle, parameters which are required in order to constrain the sources of the instabilities that lead to the eruptive phenomena. To accomplish these goals, we request 2 HST orbits to observe HD 5980 with STIS in order to obtain one set of FUV MAMA and CCD spectra at the eclipse, when the LBV occults its WR companion.

The study of HD 5980 and the UV spectrum that we propose to acquire are relevant to a broad range of problems including wind-wind collision phenomena, the formation of circumstellar structures powered by stellar winds and the evolution of supernova progenitors.

Proposal Category: GO
Scientific Category: Resolved Stellar Populations
ID: 13374
Program Title: Extremely faint, diffuse satellite systems in the M31 halo: exceptional star clusters or tiny dwarf galaxies?

Principal Investigator: Dougal Mackey

PI Institution: Australian National University

Recent years have seen the discovery of a variety of low surface brightness, diffuse stellar systems in the Local Group. Of particular prominence are the ultra-faint dwarf satellites of the Milky Way and the extended globular clusters seen in M31, M33, and NGC 6822. As part of the major Pan-Andromeda Archaeological Survey (PAndAS) we have discovered several very faint and diffuse stellar satellites in the M31 halo. In Cycle 19 we obtained ACS/WFC imaging for one of these, PAndAS-48, which has revealed it to be a puzzling and unusual object. On the size-luminosity plane it falls between the extended clusters and ultra-faint dwarfs; however, its characteristics do not allow us to unambiguously class it as either type of system. If PAndAS-48 is an extended cluster then it is the most elliptical, isolated, metal-poor, and lowest-luminosity example yet uncovered. Conversely, while its properties are generally consistent with those observed for the faint dwarf satellites of the Milky Way, it would be a factor ~2-3 smaller in spatial extent than its Galactic counterparts at comparable luminosity. Here we propose deep resolved imaging of the remaining five similar objects in our sample, with the aim of probing this hitherto poorly-explored region of parameter space in greater detail. If we are able to confirm any of these objects as faint dwarfs, they will provide the first insight into the behaviour of this class of object in a galaxy other than the Milky Way.

Proposal Category: GO

Scientific Category: Resolved Stellar Populations

ID: 13375

Program Title: Deep photometry of two accreted families of globular clusters in the remote M31 halo

Principal Investigator: Dougal Mackey

PI Institution: Australian National University

Globular clusters (GCs) are fossil relics from which we can obtain critical insights into the merger and accretion events that underlie hierarchical galaxy assembly. As part of the major Pan-Andromeda Archaeological Survey (PAndAS) we have discovered two groups of GCs that closely trace narrow stellar debris streams in the M31 halo. These clearly represent two distinct accreted families of GCs - the only known examples apart from the few Galactic GCs arriving with the Sagittarius dwarf. We propose to obtain deep ACS imaging of 14 GCs spanning these two accreted families, allowing us to measure the constituent stellar populations, line-of-sight distance, and structural parameters of each object. We will, for the first time, quantify the typical properties of accreted GCs in the M31 halo as well as the degree of variation amongst them, and how closely they correspond to the suspected accreted GC population in the Milky Way. Combined with new radial velocity measurements for the GCs, our proposed observations will allow us to trace the 3D orbits of the two streams within the M31 halo, and thus break the main degeneracies that plague numerical models designed to probe the gravitational potential and distribution of dark mass.

Proposal Category: GO

Scientific Category: Resolved Stellar Populations

ID: 13376

Program Title: The Star Formation History of Leo P

Principal Investigator: Kristen McQuinn

PI Institution: University of Minnesota - Twin Cities

The nearby (D = 1.7+/-0.3 Mpc), very low luminosity (M_V = -9.3+/-0.4mag), gas-rich star forming galaxy Leo P was discovered by its HI 21cm emission in the Arecibo ALFALFA survey. Follow-up optical spectroscopy of its single HII region revealed an oxygen abundance of 12+log(O/H)=7.16+/-0.04, making it the lowest metallicity star forming galaxy in the Local Volume (D < 5 Mpc) and commensurate with the metallicities of emission line galaxies I Zw 18 and DDO 68. Thus, Leo P presents us with a unique opportunity to understand the evolution of extremely metal deficient (XMD) galaxies. Specifically, an HST color magnitude diagram which reaches below the red clump stars will allow us to reconstruct the lifetime star formation history with reasonable time resolution.

The star formation history will answer two vital questions: (1) Did Leo P experience suppressed star formation during its early evolution like another isolated dwarf galaxy Leo A? and (2) What fraction of all newly created metals has Leo P been able to retain during its lifetime?

Proposal Category: GO

Scientific Category: Hot Stars

ID: 13377

Program Title: Essential UV Observations of Eta Carinae's Change of State

Principal Investigator: Andrea Mehner

PI Institution: European Southern Observatory - Chile

Eta Carinae is now passing though a critical phase in its evolution as it recovers from its ``Great Eruption'' 170 years ago. About 12 years ago we began to see a dramatic and unpredicted change in eta Car's long-term behavior. The brightening rate suddenly accelerated, so by 2010 the central star had brightened by more than a factor of four in the near-UV. Between 2003 and 2010 the stellar-wind emission lines weakened by factors of 2 to 4(!) implying a rapid decrease in its mass loss rate. Eta Car is unsteadily returning to its pre-eruptive state, but the rapidity since 2000 has been astonishing. The recent secular changes are much stronger in the UV than at optical wavelengths, but no UV data have been obtained since 2010 and no far-UV observations since 2004. The extraordinary brightening and changes in the wind are fundamental and must indicate basic changes in the outer structure of this circa-130 Msun star. Therefore, this proposal focuses on the rapid secular changes rather than the expected 2014.6 periastron passage. This is primarily a UV problem, though longer wavelengths are also worthwhile. Fresh observations must be done early in Cycle 21 before the approaching periastron alters the system. Our highest priorities are the UV brightening and the long term changes in the wind.

Proposal Category: GO
Scientific Category: ISM and Circumstellar Matter
ID: 13378
Program Title: Toward A Comprehensive Kinematic and Chemical Survey of the Young O-rich SNR 1E 0102-7219 in the SMC

Principal Investigator: Dan Milisavljevic
PI Institution: Harvard University

We propose the first comprehensive UV and optical imaging survey of the young, oxygen-rich, SMC supernova remnant 1E 0102-7219 (E0102). These data will be coordinated with an optical spectroscopic survey of E0102 already in progress that has uncovered previously unknown high velocity S-rich ejecta and an elaborate bubble-like, large-scale ejecta structure having a velocity distribution that spans more than twice the currently accepted mean value.

Combining the proposed WFC3 UV and optical imaging with our recent spectroscopic survey will allow: (1) the first complete mapping of E0102's high and low velocity metal-rich ejecta, (2) a first-of-its-kind map of UV emission in [Ne IV] 2425 and Mg II 2800 of an O-rich SNR, (3) identification of remnant regions exhibiting sulfur emission associated with the inner Si,S,Ca,Ar layer of the progenitor star, (4) investigation of an expected population of exceptionally high velocity, outer knots like those seen in Cas A, (5) calculation of an accurate mean expansion velocity and age via proper motions using archival HST data, and (6) creation of a high-resolution 3D kinematic and chemical reconstruction of E0102's UV and optically emitting ejecta.

This data set will reveal E0102's full structure in extraordinary detail, and provide powerful insights on the dynamics and nucleosynthesis yields of high-mass progenitor core-collapse supernova explosion models. It will also set the stage for more expansive multi-wavelength studies that can incorporate the already rich data available in Chandra X-ray and Spitzer infrared observations.

Proposal Category: GO
Scientific Category: Resolved Stellar Populations
ID: 13379
Program Title: Multiple stellar populations in the young Large Magellanic Cloud cluster NGC1856

Principal Investigator: Antonino Milone
PI Institution: Australian National University

The recent discovery of multiple sequences in the color-magnitude diagram of Galactic globular clusters have demonstrated that star clusters have experienced a complex star-formation history. Apparently, the only way to explain the main sequence splitting appears to be the product of hot CNO burning, including He, which can be enriched up to an astonishingly high Y~0.40. Recent discoveries have demonstrated that the CMDs of a large fraction of intermediate-age clusters in the Magellanic Clouds (~70 %) are not consistent with the simple, single stellar population hypothesis. The conditions under which star clusters experience the formation of multiple generations remain controversial.
A breakthrough understanding of the problem can be provided by the young stellar clusters, where second generation of stars may be forming, or just formed. However, these objects have been poorly studied to date. To properly constraint the multipopulation phenomenon, we propose deep UVIS imaging of the ~300 Myrs old LMC star cluster NGC 1856 which, according to a recent study, is the best candidate to host multiple stellar populations. The proposed observations will allow us to accurately measure possible age difference between the stellar populations providing fundamental clues on the formation mechanism. Our simulations of WFC3 performance suggest that our observing strategy allow us to detect a main sequence split caused by an He difference as small as Delta Y ~0.03.

Proposal Category: GO
Scientific Category: Debris Disks
ID: 13381
Program Title: STIS Coronagraphy of Four Young Debris Disks Newly Uncovered from the NICMOS Archive

Principal Investigator: Marshall Perrin
PI Institution: Space Telescope Science Institute

We propose STIS coronagraphic observations of four debris disks, each recently seen in scattered light for the first time in our archival reanalysis of NICMOS coronagraphy. Our targets are young (<30 Myr) solar type (G2-F3) stars; observing them will triple the number of debris disks imaged around sunlike stars at ages comparable to when terrestrial planets were forming in our solar system. STIS coronagraphy will dramatically surpass the NICMOS discovery images, with 2x better angular resolution and much improved contrast and sensitivity. These observations will allow us to measure in detail the disk geometries, determining whether parent bodies are constrained in "birth rings" analogous to the Kuiper Belt, and to search for the signatures of unseen planets gravitationally stirring the disks, potentially leading to stochastic giant collisions that might produce observable signatures in disk and dust properties. Only HST/STIS is capable of obtaining at optical wavelengths the necessary high angular resolution, subarcsecond high contrast, and image fidelity that are essential for tracing the faint extended components of these disks.

Proposal Category: GO
Scientific Category: Quasar Absorption Lines
ID: 13382
Program Title: Warm Gas Flows in the Coma Cluster

Principal Investigator: Mary Putman
PI Institution: Columbia University in the City of New York

The flow of baryons into dark matter halos varies by halo mass, but is predicted to be filamentary in all cases. We propose to observe the flow of baryons relative to the most massive structures in the universe by creating the first map of the distribution of warm gas (Ly-alpha absorbers) in and around the Coma Cluster. The total amount of warm gas, covering fraction and structure will be compared to the less massive, irregular Virgo Cluster, the field, and simulation predictions. These absorbers are our only method of directly measuring the kinematics of Coma's diffuse gas. Coma is the benchmark cluster for models of cluster formation, and the data will be combined with the rich multi-wavelength data available and used to constrain these models.

Proposal Category: GO
Scientific Category: Quasar Absorption Lines
ID: 13383
Program Title: Measuring the Properties of Dwarf Streams

Principal Investigator: Mary Putman

PI Institution: Columbia University in the City of New York

We propose to measure the metallicity and ionization conditions of a gaseous stream trailing behind a pair of dwarf galaxies in the local universe. The NGC 4532/DDO 137 system is a clear analog to the Milky Way's massive satellite galaxies, the Large and Small Magellanic Clouds; however, this system is not in close proximity to a massive spiral galaxy. Furthermore, it is the only other dwarf stream for which the metallicity and ionization conditions can be directly measured due to the fortuitous alignment of a bright background QSO with the HI stream. We will use the data to examine the properties and formation mechanisms of such streams and how they differ with environment. Such information can be used to develop a method to discriminate between cold accreting filaments and streams stripped from low mass galaxies at all redshifts.

Proposal Category: GO
Scientific Category: Unresolved Stellar Populations
ID: 13384
Program Title: A Simultaneous Measurement of the Cold Gas, Star Formation Rate, and Stellar Mass Histories of the Universe

Principal Investigator: Dominik Riechers

PI Institution: Cornell University

We have recently initiated a study that has the potential to fundamentally change our picture of galaxy evolution. Using the Jansky Very Large Array, we target a "Molecular Deep Field" to measure, for the first time, the unbiased cosmic evolution of the gas content of galaxies ("Cold Gas History of the Universe") at high redshift. We here request HST ACS and WFC3/IR observations to determine the rest-frame optical morphologies and spatially resolved star formation and

stellar mass properties of the galaxies in this region to simultaneously measure the cold gas, star formation rate and stellar mass histories of the universe in a common legacy field. The high resolution and sensitivity of the HST data will allow us to directly tie the gas content, gas fractions, and star formation rates to the structural properties of galaxies. This will provide a deeper understanding of the drivers of star formation and stellar bulge/disk growth based and their connection to the gas supply and dynamics in galaxies, as well as the relative importance of mergers vs. passively evolving galaxies. The proposed inexpensive study will also enable us to study the star formation properties of the most distant spectroscopically confirmed galaxy protocluster at z=5.3. With ALMA, we have serendipitously discovered a new population of [CII]-luminous, otherwise undetected galaxies at the redshift of this protocluster. The proposed WFC3/IR data will likely be deep enough to detect the rest-frame UV emission from these enigmatic galaxies, enabling us to investigate their true nature.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13385
Program Title: Is there a kicked supermassive black hole in E1821+643?

Principal Investigator: Andrew Robinson

PI Institution: Rochester Institute of Technology

The formation of binary supermassive black holes (BBH) in galaxy centers appears to be an inevitable consequence of hierarchical structure formation. General Relativity predicts that, when a BBH coalesces, the merged SMBH recoils with a velocity that may reach several 1000 km/s. The luminous quasar E1821+643 is one of only 3 SMBH recoil candidates that have been identified via Doppler shifting of emission lines from the retained gas. This case is unique in that the Doppler shift is seen in both direct and scattered light, allowing us to infer a relative velocity of 2100 km/s between the quasar nucleus and host galaxy. By itself, this does not exclude alternative models such as a BBH or anisotropic wind, but follow-up spectroastrometric measurements reveal a relative displacement between the nucleus and the gas emitting the [OIII]4959,5007 lines that is consistent with the recoil hypothesis. The apparent displacement, however, could also be due to an asymmetric circum-nuclear distribution of the [OIII] emission. In order to distinguish between these two possibilities we propose ACS/WFC ramp filter imaging in [OIII] to map the distribution of narrow-line emission on sub-arcsecond scales. The observations will also allow us to study the relationship between the narrow-line gas and the arcsecond-scale radio source, which has morphological features that may relate to precession in a BBH system, or a "spin-flip" following coalescence. With this modest investment of HST time we will take a key step in establishing the nature of the E1821+643 system, which may ultimately yield direct observational evidence for BBH coalescence and high velocity gravitational recoils.

Proposal Category: GO
Scientific Category: Cosmology
ID: 13386
Program Title: Frontier Field Supernova Search

Principal Investigator: Steven Rodney

PI Institution: The Johns Hopkins University

The Frontier Fields program presents an extraordinary opportunity for the detection of high redshift supernovae (SNe). The combination of very deep imaging in each epoch with the added boost from gravitational lensing magnification will provide the means to detect both Type Ia SNe (SNIa) and core collapse SNe (CC SNe) out to z~3. We propose to capitalize on this unique new asset by processing and searching all of the Frontier Field data, and then triggering ToO follow-up observations for SNe of interest.

We expect to discover ~20 new SNe over the entire 3-year program, including ~5 SNIa at z>1.5 and ~6 with strong lensing magnification. These samples are small but special: the high-z SNIa set has unique leverage for testing SNIa progenitor models through the delay time distribution; the lensed SNIa offer a chance to validate cluster mass models by directly measuring the lensing magnification. We will also be able to extend CCSN rate measurements for the first time beyond z~1, and our search will open up the small but exciting possibility of catching a truly rare event such as a multiply imaged SN or a superluminous SN at z>4.

This follow-up program provides the color and light curve information necessary to unlock the science potential of these SNe. It is also designed for high efficiency: broad-band photometry and ground-based spectroscopy will be used to classify and characterize most of the SNe. For a small "New Frontier" sub-set comprising the SNIa candidates at never-before-seen redshifts, we will employ a novel medium band IR imaging strategy. All told, this program will classify and characterize all SNe of interest with just 60 orbits across 3 cycles.

Proposal Category: GO

Scientific Category: Hot Stars

ID: 13388

Program Title: Fundamental properties of novae outburst: Coordinated HST and XMM ToO observations

Principal Investigator: Gregory Schwarz

PI Institution: American Astronomical Society

We propose non-disruptive ToO observations of two optically bright Galactic novae in outburst to observe their temporal UV evolution using the HST/STIS echelle. One ToO will target a Carbon-Oxygen type nova, which are not in the Galactic archive, and the other ToO will be reserved for the next high energy gamma-ray detected nova. The Fermi/LAT detection of high energy gamma-rays is a recent and unexpected discovery whose mechanism in classical novae is not currently understood. In both cases, UV spectroscopy is essential for determining the physical properties of the ejecta which carry the imprint of the thermonuclear runaway: elemental abundances, mass, dynamics, and structure. The UV provides the only opportunity to observe important nucleosynthetic ions, especially carbon, and the full velocity and density structure of the ejecta along with direct measurement of ions along the interstellar line of sight. STIS is currently the only instrument that provides the necessary resolution (R = 30,000 - 45,000) in the UV (1100-3100 Angstroms). Each nova target would also be observed with a single, high resolution XMM/RGS exposure (E/DeltaE ~ 500) obtained while X-ray luminous (as determined by our Swift X-ray monitoring). The XMM observations provide critical information about the conditions of the hot, luminous white dwarf that powers the radiative outburst and cannot be obtained from the low spectral resolution Swift X-ray imaging. We will combine this UV and X-ray dataset with our existing ground based optical, infrared, and radio plus Swift X-ray/UV nova ToO programs to obtain fully pan-chromatic observations of two novae in outburst.

Proposal Category: GO

Scientific Category: Cosmology

ID: 13389

Program Title: The Ultraviolet Frontier: Completing the Census of Star Formation at Its Peak Epoch

Principal Investigator: Brian Siana

PI Institution: University of California - Riverside

We propose deep WFC3/UVIS F275W and F336W (8 orbits per pointing per filter) near-ultraviolet imaging of three of the four "Frontier Field" lensing clusters. These observations will complete the legacy of Hubble imaging in these fields and detect >100 dwarf galaxies (M_UV > -17) in four redshift bins between 0.5<z<3.0, enabling the following science.

1) Measurement of the luminosity and physical extent of the far-UV emission of lensed dwarf galaxies (7.5<log(M*)<9) at 0.5<z<1.5. With these data we can determine the typical duration and surface density of star formation in galaxies in which supernovae feedback should be particularly important.

2) Enable study of galaxies from 1.5<z<3, the peak epoch of star formation, via identification of their Lyman break. Accurate photometric redshifts via Lyman breaks are critical for identifying young dwarf galaxies which often have flat, featureless spectral energy distributions. The data will also enable measurement of (or significantly constrain) the Lyman continuum emissivity of ~20 (~12) dwarf galaxies at z~2.5 (z~3.1) that are analogous to the higher redshift galaxies which reionized the universe.

3) Detect and spatially resolve ongoing star formation in early type galaxies in the foreground clusters. The detection of such star formation (or lack of it) will constrain the mechanisms for quenching star formation and transitioning galaxies to the red sequence.

The parallel fields will be imaged in F435W and F606W to nearly double the exposure time of the Frontier parallel field

Proposal Category: GO

Scientific Category: Resolved Star Formation

ID: 13390

Program Title: A Time-Lapse Movie of the Kinematics Across the Carina Nebula with ACS

Principal Investigator: Nathan Smith

PI Institution: University of Arizona

In HST cycles 13 and 14, we conducted an ACS H-alpha imaging survey of the Carina Nebula that covered 540 square arcminutes, concentrating on the two 2-3 Myr old central massive star clusters and several surrounding regions with propagating massive star formation. Now we aim to duplicate our previous program with the same filter and instrument in order to measure proper motions over a 9-10 year time baseline. These observations have two chief goals: (1) We will measure proper motions of the 40 jets discovered in our previous survey (anything moving faster than the sound speed in ionized gas), in order to measure their ages and transverse velocities, plus motions of a number of prominent shock structures. Combining the proper motions with spectra will reveal their true 3D kinematics and mass-loss histories. (2) We will measure the proper motions of all stellar point sources with luminosities above roughly 1 Msun and transverse motion faster than about 3 km/s. Combining this with ground-based spectra (mostly for O, B, and A stars) will provide a 3D kinematic map of the stars over a range of initial masses. This will easily identify any runaway massive stars, but will also track the slower collective motion of sub-clusters. Because Carina is at only 2.3 kpc, this will yield the most complete census of global stellar kinematics in a massive OB association - in one which is caught at such a young age that the "cluster of clusters" still bears the kinematic imprint of propagating star formation. The detailed kinematics will allow the first definitive test of whether the distributed generations of stars were actually triggered by the feedback from the central clusters.

Proposal Category: GO
Scientific Category: Resolved Star Formation
ID: 13391
Program Title: WFC3-IR Imaging of Dense, Embedded Outflows from Intermediate-Mass Protostars in Carina

Principal Investigator: Nathan Smith
PI Institution: University of Arizona

Based on H-alpha imaging of the Carina Nebula with ACS, we discovered 40 new Herbig-Haro (HH) jets marking outflows from young stars. This is valuable because (1) it is a large sample of jets at one distance, (2) the driving sources are intermediate-mass (IM) stars (1-8 Msun), allowing us to investigate the bridge between low- and high-mass star formation, and (3) the jets are exposed to the same feedback source and trace various stages of being uncovered by the advancing ionization front. This sample is all the more valuable because it can be placed in the context of a well-understood environment that has been studied extensively with HST, Spitzer, Chandra, and from the ground.

We propose to image 13 of these jets in the [Fe II] 1.26-micron and 1.64-micron lines. These lines suffer less extincton than optical lines, trace embedded jets, and are essential to measure the total mass in these dense outflows. Four jets have already been imaged in the F126N and F164N filters to make public release images; these images demonstrate that [FeII] emission traces a large mass of neutral gas not seen in H-alpha emission and traces the jet back into the cloud to the Spitzer-identified driving source. This study will permit a detailed comparison of the jet properties (e.g. mass-loss rate, momentum injection, mass-loss history) to IM protostar properties (e.g. accretion rate, luminosity, envelope mass and structure) during the most active accretion. These relationships are poorly determined for IM protostars. Additionally, the flux ratio of [Fe II] lines will trace the spatially dependent extinction through the cloud, providing a map of the density structure in the extended envelope.

Proposal Category: GO
Scientific Category: ISM and Circumstellar Matter
ID: 13392
Program Title: Six in One Blow: Reconstructing the Circumstellar Environments of Supernovae in NGC 6946 with Light Echoes

Principal Investigator: Ben Sugerman
PI Institution: Goucher College

Reconstructing the circumstellar (CS) environment around a supernova (SN) is critical to studying the evolution and mass-loss mechanisms of massive stars, and in establishing the extent to which SNe and their progenitors contribute to the dust found in the early universe. Over the last decade, we have been performing all of these studies through imaging analyses and radiative-transfer modeling of HST optical and Spitzer mid-IR observations of the three SNe 1980K, 2002hh, and 2004et (all within "The Fireworks Galaxy" NGC 6946). These SNe all show evidence of optical and thermal echoes (see below) off of CS material. For each object, a variety of actual CS geometries fit the data equally well, since we have no recent optical images to disentangle important ambiguities in our analyses. Using 5 orbits of HST WFC3/UVIS and 1.6 hours of Spitzer, we propose to image these 3 SNe, which will provide crucial late-time data needed to complete our light-echo modeling. We will also attempt to recover the historic SNe 1917A and 1969P, and will continue our studies of the SN-imposter 2008S, all of which are in the same fields of view.

Light echoes are one of the most powerful and efficient means to directly probe of the structure and composition of dust in CS environments, since echoes provide exact three-dimensional positions of dust while constraining its density, grain-size and chemical make-up. However, echoes pass through a given point only once, and since potential data are

permanently lost for each epoch that echoes are not observed, most of the science we propose cannot be achieved if these observations are not taken this cycle.

Proposal Category: GO
Scientific Category: Unresolved Stellar Populations
ID: 13393
Program Title: Galaxy Transformation in the Infall Regions of Clusters

Principal Investigator: Dennis Zaritsky
PI Institution: University of Arizona

The rise in the number of S0's in dense environments since z = 0.5, and the corresponding decline in spiral galaxies, points strongly to S0's being a product of the hierarchical processes that build structure. However, the physical mechanism responsible for the transformation from spiral to lenticular is hotly debated and several viable candidates exist. We propose a survey of the infall regions of clusters, as traced using our existing wide field spectroscopic survey of groups and clusters at 0.4 < z < 0.8 out to ~3 virial radii, to discriminate between these mechanisms, whose effectiveness varies with environment. By determining where S0's form, rather than where they are ultimately found in great numbers (i.e. massive clusters), and by examining whether the bulge populations of these infalling systems are young, we will determine what processes are responsible for creating the large stellar bulges in these systems. By reaching out to at least 3 virial radii, we will be studying the regions from which over 90% of the galaxies that reside in today's clusters come from, as such we are guaranteed to be observing galaxies before, during, and after this transformation.

Proposal Category: GO
Scientific Category: Resolved Stellar Populations
ID: 13394
Program Title: Spectroscopic confirmation of the first symbiotic star in a globular cluster

Principal Investigator: David Zurek
PI Institution: American Museum of Natural History

We have recently discovered an 18-minute period in the ultraviolet of a star in the globular cluster NGC 1851. In the redder optical bands, this star is red and bright, while it shows a clear UV excess relative to other stars at similar positions in the HR diagram. The system is most likely a symbiotic binary, composed of a cool evolved star and a white dwarf, with an 18 minute spin period, accreting the cool star's wind. The binary would be the first such object ever found in a globular cluster, and only the third in the Galaxy where the white dwarf spin period is measured. The only viable alternatives are that the two components are a chance superposition -- something with a nontrivial chance of happening in a globular cluster core. In such a case, the 18 minute period would most likely be the spin period of a magnetic white dwarf in an intermediate polar cataclysmic variable (this would be the first confirmed magnetic CV in a globular cluster), or the orbital period of a double-degenerate AM CVn binary. Each of these three possibilities show

unique (and very different) emission line spectra in the blue wavelength range. Two orbits of HST with STIS/G430L will produce a spectrum of sufficient signal-to-noise to distinguish between these 3 scenarios. The result will be an important constraint on N-body models of globular clusters.

Proposal Category: GO
Scientific Category: Solar System
ID: 13396
Program Title: Dual views of Saturn's UV aurora: revealing magnetospheric dynamics

Principal Investigator: Sarah Badman
PI Institution: University of Leicester

The Cassini spacecraft has made many exciting discoveries during its exploration of Saturn, but some observations of dynamic processes coupling the magnetosphere and ionosphere still require explanation. Our proposed observations exploit the presence of Cassini at Saturn to provide dual views of the aurorae, which show a snapshot of the global magnetospheric dynamics. A key target is the simultaneous observation of the northern aurorae by HST and the southern aurorae by Cassini. Such conjugate viewing is very rare and will provide fundamental insight on magnetospheric and auroral processes. We propose three complementary observing strategies targeted at elucidating: (i) North-south asymmetries: modes of solar wind-magnetosphere-ionosphere coupling, (ii) Relationship of equatorial and auroral enhancements: acceleration mechanisms, and (iii) 3-D structure of the aurora: electron energy and origin. The expected results will impact the broader astronomical community by revealing the electromagnetic interaction of planets with their local and stellar plasma environments, and the origin of periodic emission signals. Only HST is capable of studying Saturn's UV aurora at the temporal and spatial resolution required to achieve the science goals in partnership with already-scheduled Cassini observations. In spring 2014 HST will have the best view of Saturn's northern polar region to date. This is probably the last opportunity for simultaneous HST-Cassini observations because Cassini's orbit will again move to lower inclination from which the aurora cannot be viewed well. This proposal responds to the Cycle 21 UV Initiative.

Proposal Category: SNAP
Scientific Category: Hot Stars
ID: 13397
Program Title: Understanding post-AGB Evolution: Snapshot UV spectroscopy of Hot White Dwarfs

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, due to their hot temperatures, to which optical colors are insensitive, and low optical luminosities. The GALEX UV surveys allowed us to extract an unprecedented, unbiased census of very hot WDs, and to fill the critical regime where post-AGB samples are very scant. From FUV, NUV and optical photometry, and optical spectra, we selected a sample of hot WDs,

including hot WDs in binaries with a cool companion (in a temperature and mass range elusive to optical surveys), as well as halo and thick-disk rare objects.

We request UV (G140L+G230L) spectra to derive the parameters of these hot WDs: T_eff, gravity, radius, L_bol, mass. In binaries, the parameters derived for the cool-star companion (from corollary data) will also enable a better distance estimate than is usually possible for hot WDs, a lower limit to the initial mass of the WD progenitor, and precise age-dating.

The results will populate the high-temperature post-AGB tracks, and allow us to address science questions concerning: evolution of high-mass post-AGB remnants (third dredge-up and born-again scenario, relevant for understanding the yield of chemical elements), initial-final mass relation, the fraction of binaries and companion mass function over a wide range of initial masses, and the hot-WD halo population, hitherto elusive. For a typical yield of the SNAPSHOT program, the sample will conclusively augment, in size and in accuracy and range of stellar parameters, the currently scant population in the very hot post-AGB regime.

Proposal Category:	GO
Scientific Category:	Quasar Absorption Lines
ID:	13398
Program Title:	A Breakaway from Incremental Science: Full Characterization of the z<1 CGM and Testing Galaxy Evolution Theory
Principal Investigator:	Christopher Churchill
PI Institution:	New Mexico State University

In the modern theory of galaxy evolution, the circumgalactic medium (CGM), the massive, metal-enriched, extended gaseous reservoir surrounding galaxies, is the environment through which the large-scale physics of galaxy formation and evolution is controlled and regulated. Testing/confronting galaxy evolution theory requires observations characterizing the CGM kinematics, geometric distribution, metallicities, and gas phases. Expensive resources have been dedicated for z~0.1 (look-back 0-2 Gyr) and for z~2.5 (10-11 Gyr), but the epoch 0.3<z<1.0 (2-8 Gyr) has been relegated to an incremental approach hampering breakaway progress in understanding and constraining galaxy evolution theory; this extended cosmic epoch ties together and therefore increases the value of the extensive z~0.1 and z~2.5 campaigns. To perform breakaway science, we must quantify the "meteorological character" of the CGM, not simply chart the "atmospheric conditions" surrounding a few galaxies, and obtain the data required to directly confront theoretical predictions.

We propose COS NUV+FUV high-resolution quasar spectra to uniformily measure OVI, CIV, and HI (and many other low and high ionization metals, including NeVII and OIV) in the CGM of 39 z=0.08-0.97 spectroscopically measured galaxies with HST images. We will augment these 39 galaxies with 12 additional galaxies from our previous programs, for a total of 51 galaxies. Our analysis directly addresses and tests the current theoretical paradigm of galaxy evolution. Our program promises a Legacy for HST, providing the essential data for ground-based follow up and for testing galaxy evolution as theory/simulations progress in coming decades.

Proposal Category:	GO
Scientific Category:	Cosmology
ID:	13399
Program Title:	Spatially Resolved WFC3/Grism Spectral Line Imaging of Gravitational Lensed Herschel-selected Luminous Dusty Starbursts
Principal Investigator:	Asantha Cooray

PI Institution: University of California - Irvine

We propose WFC3 G102 and G141 grism spectral imaging of two gravitationally lensed dusty, starburst galaxies found with the 600 square degree Herschel-ATLAS survey. One galaxy is the brightest (both in far-IR at 250 micron and in near-IR in J/K-band), while the second is the largest (11 arcsec on the sky) of the lensed sub-mm galaxies in a sample of 200 imaged with WFC3/F110W. The two galaxies are at redshifts that are optimal for grism observations with HST/WFC3. The lensing flux magnification and spatial enhancement makes them very unique for the study proposed here
and will increase the number of lensed galaxies imaged in spectral lines with WFC3 grisms to three from existing single serendipitous lens studied in HST-3D survey. With WFC3 grism spectra taken in a specific orientation to minimize foreground and lensing galaxy confusion we can map each of these galaxies in a variety of spatially-resolved spectral lines in the rest-frame optical, including impostant Balmer lines for studies on the interstellar medium. The grism spectra will allow us to determine the gas-phase metallicities of these two galaxies and to study the extinction of optically-thin regions compared to direct sub-mm emission seen in interferometric continuum images of optically thick dust in starbursting knots and clumps. With spatial resolution provided by gravitational lensing combined with HST/WFC3 resolution, we will be able to study the dependence of line ratios in high density/SFR regions to low dense diffuse environments.

Proposal Category: GO

Scientific Category: Hot Stars

ID: 13400

Program Title: The Surprising Ejecta Geometry of Recurrent Nova T Pyx

Principal Investigator: Arlin Crotts

PI Institution: Columbia University in the City of New York

Given the striking appearance of the old remnant that surrounds T Pyxidis (T Pyx), and the rapid pace at which this binary is currently evolving, T Pyx is one of the most stunning and interesting recurrent novae (RNe). But it is also one of the most disobedient, with the rate of mass transfer, the mass of the white dwarf, and the speed of the eruptions all inconsistent with standard expectations. In 2011, T Pyx experienced its first eruption in 45 years, providing observers with the long-awaited opportunity to determine the detailed properties of a T Pyx explosion and to test ideas about how these events might have led to T Pyx's unusual state. Our Cycle 20 HST observations of the light echo from the old remnant and direct line emission from the young remnant from 2011 provided one of several surprises: much of the old and young ejecta form a disk or ring inclined with respect to the plane of the sky. The 2011 ejecta also contain multiple kinematic components. But our Cycle 20 observations did not cover enough position angles, or span a long enough time baseline, to enable us to fully disentangle the spatial and velocity structure of the young remnant. In Cycle 21, we propose to take advantage of the unique moment in time when the young remnant is both large enough and bright enough for the spatial extent, expansion, and velocity structure to be clearly mapped. This research has implications for our understanding of the mass expelled in the 2011 eruption of T Pyx, the shaping of nova remnants, and the potential influence of nova eruptions on binary stellar evolution and the production of type Ia supernovae.

Proposal Category: GO

Scientific Category: ISM and Circumstellar Matter

ID: 13401

Program Title: A 3D view of the SN 1987A Ejecta

Principal Investigator: Claes Fransson

PI Institution: Stockholm University

SN 1987A represents the most important source of information about the explosion physics of any SN. For this the morphology of the ejecta is together with the radioactive isotopes the best diagnostics. From HST imaging in H-alpha and NIR AO imaging in Si/Fe at 1.64 mu one finds completely different morphologies, with the 1.64 mu image dominated by the processed core and H-alpha by the surrounding H envelope. Besides Cas A (Type IIb), this is the only core collapse SN where we have this information. We propose to use STIS to map the debris in SN 1987A in 3D with the best possible angular resolution. There has been no such STIS map since 2004, while the physics of the emission has undergone some profound changes. From being powered by radioactivity the energy input is now dominated by X-rays from the collision with the circumstellar ring. Compared to 2004 the 3D structure can be determined with a factor of ~ 3 better spatial resolution and also better spectral resolution. The 3D structure in H-alpha can also give independent clues to where the large mass of dust detected by Herschel is located as well as its properties. It also gives a complementary view of the ejecta to the future ALMA imaging in CO which will have similar spatial resolution. Besides the debris we will be able to probe the ~ 10,000 km/s reverse shock close to the ring in H-alpha. By observing this also in Ly-alpha one may test different emission processes which have been proposed, as well as probing the region producing the synchrotron emission observed by ALMA. The opportunity to observe the SN in this stage will never come back!

Proposal Category: GO

Scientific Category: Solar System

ID: 13402

Program Title: Remote sensing of the energy of Jovian auroral electrons with STIS: a clue to unveil plasma acceleration processes

Principal Investigator: Jean-Claude Gerard

PI Institution: Universite de Liege

The polar aurora, an important energy source for the Earth's upper atmosphere, is about two orders of magnitude more intense at Jupiter where it releases approximately 10 GW in Jupiter's thermosphere. So far, HST observations of Jupiter's aurora have concentrated on the morphology and the relationship between the solar wind and the brightness distribution. While STIS-MAMA is still operational, time is now critical to move into a new era where FUV long-slit spectroscopy and the spatial scanning capabilities of HST are combined. We propose to use this powerful tool to remotely sense the characteristics of the precipitated electrons by slewing the spectral slit over the different auroral components. It will then be possible to associate electron energies with spatial auroral components and constrain acceleration mechanisms (field-aligned acceleration, magnetic field reconnection, pitch angle electron scattering) associated with specific emission regions. For this, a combination of FUV imaging with STIS long slit spectroscopy will map the spatial variations of the auroral depth and thus the energy of the precipitated electrons. These results will be compared with current models of the Jovian magnetosphere-ionosphere interactions and will provide key inputs to a 3-D model of the Jupiter's atmosphere global heat budget and dynamics currently under development. This compact timely program is designed to provide a major step forward for a better understanding of the physical interactions taking place in Jupiter's magnetosphere and their effects on giant planets' atmospheres, a likely paradigm for many giant fast spinning planets with massive magnetic field in the universe.

Proposal Category: GO
Scientific Category: Solar System
ID: 13404
Program Title: Mutual Orbits and Physical Properties of Binary Transneptunian Objects

Principal Investigator: William Grundy

PI Institution: Lowell Observatory

Intriguing patterns are evident in both the orbits of transneptunian objects and in their observable external characteristics (colors, spectral features, etc.). Bulk physical properties are needed to make sense of these observations and exploit them to constrain conditions in the protoplanetary disk where they formed. The key to obtaining bulk properties of transneptunian objects is that a sizeable proportion of them are binaries. Binary mutual orbits provide dynamical masses that can in turn be used to compute bulk densities, and a statistical sample of binary orbits offers powerful constraints on formation mechanisms as well as subsequent evolution. This proposal seeks to continue a multi-year campaign to obtain orbits for as large of a sample of binary transneptunian objects as possible. We seek to make efficient use of HST by targeting only the systems where we can obtain a dramatic improvement in orbital knowledge from just one or two visits, and only those where the secondary is too faint to pursue with ground-based near-IR adaptive optics techniques.

Proposal Category: GO
Scientific Category: ISM and Circumstellar Matter
ID: 13405
Program Title: SAINTS: Images of SN 1987A

Principal Investigator: Robert Kirshner

PI Institution: Harvard University

SN 1987A is the great supernova of the HST era. It is the only case where we have detailed knowledge of the pre-existing structure in the circumstellar gas. It is the only case where we can observe the details of a transition from supernova to supernova remnant. An unbroken string of observations is the essential tool for detecting change and establishing a uniform legacy archive. As we have demonstrated, images reveal a wide variety of processes at work-- most notably the change in the energetics of the debris from radioactive power in the first 5000 days to X-ray illumination from the outside at the present day. We also observed the explosive eruption of "hotspots" around the circumstellar ring and are now using their time history to infer their structure. We have devised a way to image the reverse shock at both Lyman alpha and H-alpha that will help solve a riddle in the excitation of these lines and illuminate the

hydrodynamics of the site where non-thermal processes are at work. We propose this novel UV work for the current cycle. The HST observations have a unique blend of photometric fidelity and angular resolution that also makes them the indispensable partner to ongoing X-ray, radio, and far-IR observations. ALMA provides a new way to

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Proposal Category: GO

Scientific Category: Debris Disks

ID: 13406

Program Title: Hydrogen, Deuterium and Nitrogen in the Beta Pictoris disk

Principal Investigator: Alain Lecavelier des

PI Institution: CNRS, Institut d'Astrophysique de Paris

The Beta Pictoris system is a young planetary system (about 10 million years old), likely at the end of the telluric planets formation phases. It is embedded in a disk which is the prototype of debris disks where both gas and dust are continuously replenished via collision and evaporation of planetesimals and comet-like bodies. Because of its edge-on inclination, the gas component of the disk can be observed in great details through absorption spectroscopy.
FUSE far UV observations allowed the discovery that the Beta Pictoris debris disk is extremely carbon rich. This unexpected carbon over-abundance is due to either a peculiar composition of the original protoplanetary system, to radiation forces blowing-out radiation-sensitives species, or to condensation/evaporation processes. Fortunately, hydrogen, deuterium and nitrogen are key volatiles sensitive to the radiation, condensation and evaporation processes. They can serve as diagnostics of the still puzzling gaseous disk history. Using COS far-UV capabilities, we propose to search for those species, which have up to now never been observed in this system. We will measure the HI, DI, and NI column density to trace the gas disk origin and provide constraints on its dynamics. The measurement of N/C ratio will also provide key information for the understanding of the observed carbon excess. These observations will bring new informations on the physical processes taking place in this active system during the last stages of the planet formation.

Proposal Category: GO

Scientific Category: ISM in External Galaxies

ID: 13407

Program Title: COS Gas Flows: Challenging the Optical Perspective

Principal Investigator: Crystal Martin

PI Institution: University of California - Santa Barbara

Observations of the hydrogen Lya profile in galaxy spectra uniquely distinguish outflowing and inflowing gas. Recent COS observations of ultraluminous starbursts show the telltale signature of infalling neutral hydrogen. A radiative transfer calculation that models the profiles of Lyman series lines predicts broad scattering wings on the hydrogen Balmer lines, but the origin of the scattered Balmer emission is only unique when the Lyb profile is also fit. We show a strong kinematic similarity between the broad wings of the Lya and Ha line profiles in ULIRG spectra raising the suggestion that the sign of the gas flows producing the broad Ha wings may have been previously misinterpreted. We propose very blue G130M spectroscopy with COS to obtain the Lyb line profiles for four starburst galaxies with the aim of establishing the correct interpretation of the broad Balmer line wings in starburst spectra.

Radiative transfer modeling has focused primarily on reproducing the Lya line shape. Calculating the Lya and Ha line profiles simultaneously in principle eliminates degenercies in model parameters. However, the addition of spectroscopy covering Lyb can significantly improve the constraints obtained from radiative transfer modeling; but because of the lack of data, no one has done this thus far. The Hubble Utraviolet Initiative should ensure that these data exist.

Proposal Category:	GO
Scientific Category:	Hot Stars
ID:	13408
Program Title:	Constraining the Physical Properties of LBV Nebulae in the Galactic Center Environment
Principal Investigator:	Jon Mauerhan
PI Institution:	University of Arizona

The Galactic center (GC) is the most extreme site of massive star formation in the Galaxy, owing to the unusually dense reservoir of molecular gas that comprises the central ~500 pc. As a result, the region contains several massive starburst clusters and largest known concentration of ultra-rare luminous blue variable (LBV) stars, unstable hot supergiants experiencing super-Eddington eruptions that hurl massive nebulae into space and deliver copious amounts of mechanical energy to the ISM. Of particular interest, there are several extraordinary hot supergiants in the GC whose massive expanding LBV nebulae afford us the opportunity to study the evolution of such structures in the unique GC environment, where the dense ISM, extreme UV field, and ferocious ambient stellar winds are expected to have significant influence over the morphological evolution of LBV mass ejections. We propose to diagnose the physical properties of known LBV nebulae in the GC by measuring the morphology and mass of their warm gas component and its physical relation to the photo-ionized component. To achieve this, we will perform WFC3 narrowband imaging of collisionally-ionized [FeII] emission and photo-ionized HI (Paschen-beta). The imaging will be supplemented with ground-based spectroscopy, which will provide the chemical and kinematical information neccessary to derive the physical properties of the nebulae from the WFC3 images.

Proposal Category:	GO
Scientific Category:	AGN QUASARS
ID:	13409
Program Title:	Hubble Observations of Kepler-Monitored Seyfert Is
Principal Investigator:	Richard Mushotzky
PI Institution:	University of Maryland

The bulk of AGN optical variability is generated by viscous processes in the accretion disk. The nature and amplitude of the variability is thought to be strongly connected to the black hole mass and Eddington ratio (McLeod et al 2010). For the past 3 years we have obtained high-precision (milli-magnitude errors), densely-sampled (every 30 min), long-duration (years) optical light curves from Kepler of 28 AGN our team has discovered in the Kepler field. These data

permit, for the first time, the precise measurement of the optical variability of a sample of AGN over a wide range of timescales (from hours to years), BH masses and Eddington ratios, allowing a detailed characterization of the variability processes.

To properly model the disk emission and probe the origin of the variability, it is necessary to measure and subtract off the substantial but uncertain contribution due to starlight in the underlying galaxy. Because of the poor angular resolution of Kepler and ground based data, only HST can obtain this data. Without this measurement it is impossible to determine the absolute variability amplitude of the AGN, an accurate black hole mass or AGN luminosity. We request 8 GO orbits for WFC3 imaging of 8 AGN selected to span a wide range of Eddington ratio and black hole mass. These 8 objects are representative of the full range of mass and Eddington ratio of the present Kepler monitored sample. HST observations are crucial to obtain the full value of the already-extraordinary Kepler AGN light curves. In addition the HST observations will determine the nature of the host galaxy, a key parameter in understanding the origin and evolution of AGN.

Proposal Category:	GO
Scientific Category:	Resolved Stellar Populations
ID:	13410
Program Title:	COSMIC-LAB: a BSS orbiting a NS? The companion to the supermassive NS in NGC6440.
Principal Investigator:	Cristina Pallanca
PI Institution:	Universita di Bologna

The observed radio properties of the binary millisecond pulsar PSR 6440B in the globular cluster NGC 6440 suggests that the neutron star (NS) could be as massive as 2.7 Msun. If confirmed, such a large value would severely challenge most of the equations of state of dense matter and put strong constraints to the formation scenarios of supermassive NSs. To confirm the expected value it is mandatory to identify the companion star to this unique object.
From the analysis of Cycle 19 WFC3 images, we identified a promising candidate companion: it is a Blue Straggler Star (BSS) showing optical variability seemingly consistent with the orbital period of the system (P=20.55 d). However these data do not allow to precisely determine the BSS variability period and verify whether it coincides with the orbital period of the pulsar.
Here we propose to perform time-resolved WFC3 observations in order to derive the BSS light curve with a temporal sampling appropriate for precisely and univocally establish its period and assess its coincidence with the pulsar orbital period. Once the candidate is confirmed, the light curve shape will constrain the orbital inclination and the mass ratio of the system. In turn, together with the companion mass estimated from stellar evolutionary tracks, this will yield the first direct estimate of the NS mass.
Note that the prohibitive crowding conditions in the vicinity of the BSS prevent any attempt to perform ground-based observations or spectroscopic follow-ups. Hence the proposed project represents the only viable approach to solve the case of PSR 6440B, potentially leading to the discovery of the first known case of a BSS orbiting a MSP.

Proposal Category:	GO
Scientific Category:	Unresolved Stellar Populations
ID:	13411
Program Title:	Dissecting the intensely star-forming clumps in a z ~ 2 Einstein Ring
Principal Investigator:	Wiphu Rujopakarn

PI Institution: University of Arizona

Clumps of star formation spreading widely in galactic disks are common features of star-forming galaxies at 1 < z < 3. This is the epoch when galaxy assembly activities peaked. These clumps could represent a pathway through which a majority of the stellar mass in the Universe was formed; understanding their formation and evolution is central to our understanding of galaxy evolution. However, the intensely star-forming clumps in disk galaxies at z ~ 2 have rarely been studied. Each of these clumps is forming stars in situ at a rate comparable to the most luminous merger-triggered starbursts in the local Universe. They are thus unique test cases to study the mechanism that drives intense star formation at z ~ 2. We propose WFC3 near-IR imaging and spatially-resolved spectroscopy of a gravitationally lensed, kinematically ordered, vigorously star-forming galaxy at z = 1.885 with physical resolutions up to 40 pc. This galaxy contains two luminous clumps that are forming stars at the rates of 100 solar mass/yr/clump. Spatially-resolved map of star formation from HST provides the most critical missing piece to interpret our existing observations of this galaxy in far-IR, CO emission lines, and radio continuum. We will probe the frontier research areas in z ~ 2 star formation, particularly the spatially-resolved star formation laws and dynamics of cold and ionized gases, which have never been probed at this spatial resolution. Our proposed observations will provide a benchmark against which to interpret the structures of vigorous star-forming clumps in general. This object can therefore have a unique impact on our understanding of the star-forming modes that dominate at z ~ 2.

Proposal Category: SNAP

Scientific Category: Cosmology

ID: 13412

Program Title: An ACS Snapshot Survey of the Most Massive Distant Galaxy Clusters in the South Pole Telescope Sunyaev-Zel'dovich Survey

Principal Investigator: Tim Schrabback

PI Institution: Universitat Bonn, Argelander Institute for Astronomy

We propose an HST/ACS Snapshot survey targeting a sample of 120 of the most massive clusters detected by the South Pole Telescope (SPT) in the redshift range 0.7<z<1.2 via the Sunyaev-Zel'dovich (SZ) effect. Together with 11 clusters from our earlier programs, this will constitute by far the largest sample of massive high-redshift clusters studied by HST. We will measure weak lensing masses with the ACS data, reaching an unprecedented 8% precision on the mean mass (9% with systematics). This will allow us to calibrate SZ, X-ray, and optical mass proxies for massive high-redshift clusters, using a sample with a uniform, well-characterized selection function. These measurements will provide the missing piece to robustly derive tight constraints on cosmology and dark energy from the SPT cluster sample. When combined with our extensive in-hand multi-wavelength follow-up, these data will constitute a tremendous legacy both for the mass calibration of future cluster surveys, and the study of the formation and evolution of massive clusters, e.g. enabling tests for deviations from self-similar evolution, and providing an important benchmark for cosmological simulations. The data will enable a wide range of additional legacy science, including a robust investigation of the frequency of giant arcs behind high-redshift clusters, and the study of star formation in high-redshift cluster galaxies. We completely waive our proprietary data rights to acknowledge the expected strong interest of the community in this rich data set.

Proposal Category: GO

Scientific Category: Unresolved Stellar Populations

ID: 13413

Program Title: Star formation and Dissolution Across Dynamically Distinct Environments in NGC 1097

Principal Investigator: Kartik Sheth

PI Institution: National Radio Astronomical Observatory

Strongly barred spirals offer a unique laboratory of dynamically distinct environments such as the bar, bar ends, nuclear and inner rings, and spiral arms where the star formation rates and perhaps the cluster dissolution rates vary by orders of magnitude. This proposal aims to add to the shallow existing F658N and F814W HST data to acquire a complete suite of U,B,V, I and Halpha data that will allow us to identify and age-data stellar clusters and measure the cluster mass functions across the various environments. The data will allow us to understand where the stars are forming, how they are evolving and travelling on the different orbital families within the bar, and at what rate they are dissolving into the field population. What makes this study timely is that we have recently been granted high resolution and sensitive observations of the molecular gas and dust in NGC 1097 with ALMA. We also have N-body and purely hydrodynamic simulations of bars that have been used previously to constrain bar dynamics using coarse and low quality data. But now together with the HST and ALMA data plus the models we can confidently measure the triggering mechanisms for star formation, the star formation efficiency, the cluster mass function and dissolution rates in the various environments across this strongly barred system.

Proposal Category: GO

Scientific Category: Solar System

ID: 13414

Program Title: Reading the Record of Cometary Impacts into Jupiter's Rings

Principal Investigator: Mark Showalter

PI Institution: SETI Institute

Images from the Galileo spacecraft were recently re-interpreted to reveal a subtle pattern of vertical "ripples" in the Jovian ring. These were shown to have been triggered during in mid-1994, and were probably associated with the impact of SL9 into Jupiter (Showalter et al., 2011, Science 332, 711-713). Additional patterns imaged by Galileo and also New Horizons indicate that these are common features of the ring; four different spiral patterns have been detected in the two data sets. Because any given pattern winds tighter at a known rate, these patterns can be used to infer the approximate the date on which the impact occurred. In addition, the vertical amplitude of the pattern constrains the impactor's mass. In Cycle 21, the rings of Jupiter are open to Earth by a small angle of 1.6 degrees, making this an ideal opportunity to detect similar patterns using HST. We will be able to detect any pattern in the ring that has an amplitude of >~ 1 km and that was triggered within the last 8-10 years. This information will provide valuable new constraints on the population of small bodies in the outer solar system.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13415
Program Title: The First Study of the Quasar Broad Line Region in the <550A Extreme UV

Principal Investigator: David Syphers

PI Institution: University of Colorado at Boulder

Quasar emission in the extreme UV (EUV, blueward of the hydrogen Lyman limit) is poorly understood, and this is especially true for the shortest observable UV wavelengths (300-550A rest). In particular, although some emission lines have been seen at very low resolution, none have been rigorously identified or studied well. We here propose the first study to definitively identify and characterize emission lines in this wavelength regime. We will observe the brightest quasar showing clear emission lines in the EUV, and compare to extant spectra for other quasars lacking such strong emission, in order to: (1) explore quasar diversity, investigating why the quasar emission spectrum varies so much between objects in the EUV when it does not in the FUV through optical; (2) test photoionization models of the broad emission line region, particularly the existing tension between line production for helium and metal lines; (3) identify emission lines in this poorly understood wavelength regime, to enable inference of the underlying EUV spectral slope, important for quasar physics and ionization of the intergalactic medium.

Proposal Category: GO
Scientific Category: Unresolved Stellar Populations
ID: 13416
Program Title: The most massive black hole in a compact galaxy UGC2698

Principal Investigator: Remco van den Bosch

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

Massive galaxies represent the extreme of galaxy formation and contain the most massive black holes (BH), as reflected in the scaling relations of BH masses with galaxy velocity dispersions (M-sigma) and luminosities (M-L). Our spectroscopic survey of 900 nearby galaxies has already yielded one of the most massive black holes in a remarkably compact galaxy NGC1277. Now we propose to obtain imaging of a nearby galaxy which may host the most massive black hole found to date. This galaxy, UGC2698, lies nearby at a distance of 89 Mpc and has an average size and luminosity, and a extremely high central velocity dispersion of 440 km/s, indicative of black hole mass in excess 10 billion solar masses. With one orbit, we can resolve its small bulge and put accurate constraints on its black hole mass (in combination with our spectroscopy). If this system also contains a very high black hole mass, it would be in stark conflict with the popular co-evolution picture.

Proposal Category: GO
Scientific Category: Extra Solar Planets
ID: 13418
Program Title: Patchy Clouds and Rotation Periods in Directly Imaged Exoplanets

Principal Investigator: Daniel Apai
PI Institution: University of Arizona

Directly imaged exoplanets offer unique insights into weakly-irradiated planetary atmospheres and into the architecture of outer planetary systems. They also raise two pivotal questions: 1) How do their atmospheres compare to brown dwarfs? and 2) How did these large-separation massive planets form? Atmospheric modeling of directly imaged planets is complicated by the presence of condensate clouds; many successful models assume patchy cloud cover, a combination of two different atmospheres (e.g. cloudy and cloud-free). Heterogeneous cloud covers are common in brown dwarfs and lead to rotational photometric variability. In addition, different planet formation models proposed for large-separation exoplanets lead to different typical rotation rates.
We pioneered HST and Spitzer rotational mapping of brown dwarfs and in a series of studies showed that this technique provides very important and unique constraints on the composition and structure of brown dwarf atmospheres and their cloud layers.
We propose here to apply high-contrast, high-precision photometry to two prototypical directly imaged exoplanets (or planetary mass companions) and search for photometric variations. The observations will: 1) verify the prediction of patchy cloud cover and allow quantitative comparisons to cloud properties observed in brown dwarfs; and, 2) provide the first direct measurements of the rotation periods of wide-separation exoplanets, an important constraint on their formation mechanism. Furthermore, the proposed observations will demonstrate a new observing technique on two low-risk targets, opening a new window on directly imaged exoplanets.

Proposal Category: GO
Scientific Category: Resolved Star Formation
ID: 13419
Program Title: The First Ultraviolet Survey of Orion Nebula's Protoplanetary Disks and Outflows

Principal Investigator: John Bally
PI Institution: University of Colorado at Boulder

The Orion Nebula contains the nearest site of massive star-formation and the largest concentration of young stars, proto-planetary disks, and outflows in the Solar vicinity. Orion is a laboratory for addressing long-standing questions in the formation massive stars, star clusters, and the evolution of proto-planetary disks. A new WFC3 UV survey of the Nebula is proposed to resolve unprecedented detail in proto-planetary disks seen in silhouette, bright proplyds, and outflows, generating the first high-resolution UV images of a Galactic massive star-forming region. In the UV, nebular background provides a backlight 10 to 30 times brighter than at visual wavelengths. Low-mass young stars are much dimmer in the UV than in the visual, so disks previously hidden by stellar glare will be detected and characterized resulting in measurements of disk sizes. The color of radiation transmitted through the translucent dust in proplyds will probe grain growth. The UV MgII, violet [OII], and new H-alpha images will provide new constraints on disk mass-

loss rates. By combining these measurements with our ALMA sub-mm determination of disk masses, disk life-times will be estimated. Outflows in the Nebula will be imaged for the first time in [OII] and [MgII] to probe the transition from neutral to ionized gas. Because of large proper motions, new WFC3 H-alpha images are required to register the MgII and [OII] data. The WFC3 H-alpha and coordinated parallel H-alpha imaging with ACS will be combined with archival HST images, to measure proper motions of nebular structures and outflows with unprecedented precision.

Proposal Category:	GO
Scientific Category:	Cosmology
ID:	13420
Program Title:	The progenitors of quiescent galaxies at z~2: precision ages and star-formation histories from WFC3/IR spectroscopy
Principal Investigator:	Guillermo Barro
PI Institution:	University of California - Santa Cruz

The important "adolescent" epoch at redshifts z~1 to 2 bridges a universe of "adult" galaxies at z<1 to an earlier "childhood" period z>2 when galaxies were dramatically different. During this transition, the early quenching of star formation and later enlargement of compact quiescent galaxies since z~2 remain key unsolved mysteries. We have identified a population of compact star-forming galaxies at ~2.5 whose structural properties and number densities suggest an evolutionary connection with the first quiescent galaxies. But demonstrating full consistency between progenitor to descendant populations requires high-precision redshifts, ages, and star formation histories to make reliable links in time. We thus propose adding a 56 orbit G102 survey to GOODS-North. The G102 grism meets the required spectral resolution to resolve stellar population ages and connect progenitors to quiescent galaxies, and perfectly bridges the gap for galaxies at 1<z<2 which was missed by the previous G141 program in GOODS-N. Combining and leveraging with the 56-orbit redder (G141) grism investment and 180 hrs of 10m-telescope (GTC) medium-band imaging (SHARDS), our survey will provide the definitive dataset for well time-resolved stellar population studies until JWST. The spatially-resolved WFC3 spectroscopy will also tackle the mystery of how quiescent galaxies grow to their larger sizes today, by measuring differences in the ages and star formation histories between their cores and outskirts during the transition era. Given its high value for legacy science, the new data will have no proprietary period.

Proposal Category:	GO
Scientific Category:	Hot Stars
ID:	13421
Program Title:	CSS 41177: an eclipsing double white dwarf binary
Principal Investigator:	Madelon Bours
PI Institution:	The University of Warwick

The overwhelming majority of stellar remnants are white dwarfs. Despite their abundance and importance to, amongst others, Galactic age determinations and our understanding of type Ia supernovae fewer than a dozen white dwarfs have model-independent measurements of fundamental parameters like mass and radius. A major limitation on the observational side is that such parameters are extremely difficult to determine in a model-independant way for single

white dwarfs. Close white dwarf binaries can provide these important tests.

The largest class of white dwarf binaries in the Galaxy are the detached double white dwarfs, which are becoming increasingly popular as the progenitor systems of Type Ia supernovae. In recent years four eclipsing double white dwarfs have been found, creating the opportunity for precision mass and radius measurements of two white dwarfs at once. Our target, CSS 41177, contains two extremely low-gravity white dwarfs with very different temperatures, presenting us with a unique chance to test the existing mass-radius relation at its extremes.

Here we propose a 2 orbit HST/COS FUV observation of CSS 41177, to accurately determine the temperature and surface gravity of the hot white dwarf. Through the flux ratio from the light curve this will at the same time constrain those of the cool white dwarf. Therefore it will allow us to add two more white dwarfs with accurate parameters to the short list of white dwarfs for which precise masses and radii are known.

Note: The proposed observations are part of the doctoral thesis of Ms. Madelon C.P. Bours.

Proposal Category:	GO
Scientific Category:	ISM in External Galaxies
ID:	13422
Program Title:	Riding the wake of a cluster merger: star formation, filaments and turbulence

Principal Investigator:	Rebecca	Canning
PI Institution:	Stanford University	

In hierarchical structure formation, galaxy clusters form via gravitational infall and mergers with subclusters, which have a dramatic impact on the properties of both the intracluster medium and the cluster galaxies. Studies of these exciting objects can constrain gas properties and structure evolution. Using Chandra X-ray observations, we have recently discovered the spectacular merging cluster Abell 2146, which has two large Mach ~2 shock fronts and a similar gas structure to the Bullet cluster. The subcluster contains a ram pressure stripped dense X-ray core of gas which shows signs of both turbulent disruption and also stabilization by magnetic fields. The brightest cluster galaxy is unique in that it is located in the wake of this disintegrating core and our OASIS IFU observations have uncovered an ordered plume of H-alpha-emitting gas coincident with the coolest and densest X-ray material trailing from the core onto the BCG. We request HST/WFC3/UVIS observations to resolve this H-alpha tail and to examine the young star formation. These observations will allow us to investigate gas transport properties in the intracluster medium and to probe the separate evolution of the X-ray cool core and the BCG. These observations will also enable us to investigate the effect of the merger enviroment on star formation in this cluster member galaxies.

Proposal Category:	GO
Scientific Category:	Quasar Absorption Lines
ID:	13423
Program Title:	Primordial lithium in z~0, metal-poor damped Lyman alpha systems

Principal Investigator:	Ryan	Cooke

PI Institution: UC Santa Cruz/ UCO Lick Observatory

A longstanding challenge for the standard model of Big Bang Nucleosynthesis is to explain the discrepancy between the predicted and observed primordial lithium abundance; the most metal-poor stars are deficient in Li by a factor of 3-4 relative to the standard model prediction. We propose to use the combined efforts of HST+COS and ground-based optical echelle spectrographs, to measure the primordial Li abundance in clouds of near-pristine gas at low redshift. To this end, we have compiled a prime list of sure candidate low-redshift damped Lyman-alpha systems (DLAs) that are in front of bright quasars. This combination is essential to detect the weak Li absorption lines arising in the ISM of external galaxies. For a small investment of HST time, we will confirm these systems as new low-redshift DLAs -- almost tripling the current number of known systems -- and discern the optimum clouds where the primordial abundance of Li can be measured. The sought-after data will also provide new opportunities to study the detailed properties of DLAs and their host galaxies, as well as the greater environments in which they reside.

Proposal Category: GO

Scientific Category: ISM and Circumstellar Matter

ID: 13424

Program Title: The Necklace Nebula as a probe of close binary evolution

Principal Investigator: Romano Corradi

PI Institution: Instituto de Astrofisica de Canarias

Mass loss from evolved stars is a fundamental but poorly understood process. In particular, the production of collimated outflows is observed in a large variery of sources, and evolution in interacting binaries has been traditionally invoked to explain it. The Necklace Nebula was only discovered in 2011 but is proving to be a key target to investigate this issue: it is one of the few planetary nebulae for which the association between close-binary evolution and the formation of jets was established, and the only one for which the jet ejection process can be directly associated with accretion on the secondary star. In particular, accretion would have occurred right before the onset of a fast evolutionary phase in which the two stars share a common envelope (CE) and then eject it. Pre-CE accretion is supported by the gas kinematical ages, and most important by our finding that the secondary star is carbon-rich, a fact that can naturally be explained by accretion from the wind of the primary when the latter was a carbon-rich AGB star. The decisive test to confirm this hypothesis, tying all loose ends about the evolution of the system, is to prove that the nebular gas is also carbon-rich. For this reason, we aim to determine the C/O abundance ratio of the nebula using COS. The HST is needed because the dominant C and O ions can only be detected at FUV wavelengths. Confirmation of our hypothesis will provide for the first time a fully consistent description of the mass loss, mass transfer and mass accretion processes occurring during CE, a phase that is crucial to understand classes of objects such as cataclysmic variables, novae, low-mass X-ray binaries, and SNIa.

Proposal Category: GO

Scientific Category: Resolved Stellar Populations

ID: 13425

Program Title: Multiwavelength Test For A Standard Accretion Disk Around An Intermediate Mass Black Hole Candidate

Principal Investigator: Hua Feng

PI Institution: Tsinghua University

Recent X-ray and optical observations suggest that the supersoft ultraluminous X-ray source in NGC 247 is an interesting candidate for an intermediate mass black hole, based on the fact that emission from an unusually cool and luminous accretion disk can explain multiwavelength data across 3 orders of magnitudes in wavelength. If the disk interpretation is valid, the source is predicted to be UV-luminous. Thus, we propose joint HST/XMM-Newton observations of the source for a definitive test of of the disk scenario and reliable measurement of the black hole mass.

Proposal Category: GO

Scientific Category: Hot Stars

ID: 13426

Program Title: Direct test for a binary progenitor of SN 2011dh in M51

Principal Investigator: Gaston Folatelli

PI Institution: Institute for Physics and Mathematics of the Universe

The Type IIb supernova 2011dh brought about an interesting debate about the nature of its progenitor star or system. Evidence from pre-explosion imaging that the exploding star was a yellow supergiant is difficult to reconcile with the theory of stellar evolution for isolated stars. Some of us have recently presented the compelling case of a close binary progenitor for this supernova where the yellow supergiant star explodes after transferring mass onto a very hot companion star. The proposed HST observations will definitely corroborate the binary progenitor scenario by confirming the disappearance of the yellow supergiant and, at the same time, detecting the proposed companion star in the UV. If this scenario is confirmed, the results will have an important impact on our knowledge of massive-star evolution and of stripped-envelope core-collapse supernovae.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13427
Program Title: A Look Inside a Star: The Evolved Main-Sequence Channel and Hydrogen Depleted Ultracompact Binaries

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

The evolutionary paths of ultracompact interacting binaries often lead to helium transfer in AM CVn systems. But an "evolved main-sequence" channel has long been hypothesized to create ultracompact binaries with detectable hydrogen. Recently, a couple of prime candidate binaries have been identified from time-domain sky surveys that appear to have evolved through this unique path. We propose COS FUV observations of CSS120422, the brightest of these candidates, to compare with the elemental abundance predictions of the evolved main-sequence model. This system has an orbital period of only 55 minutes, well below the hydrogen period minimum. The optical spectrum of CSS120422 is clearly depleted in hydrogen relative to helium, but still has two orders of magnitude more hydrogen than AM CVn stars. The CNO abundance ratios that are available only in the UV provide a stringent test of the evolved main-sequence scenario.

Proposal Category: GO
Scientific Category: Cool Stars
ID: 13428
Program Title: Characterizing the Ultra-cold Brown Dwarf WD 0806-661B

Principal Investigator: Christopher Gelino
PI Institution: Jet Propulsion Laboratory

WD 0806-661B, a common proper motion companion to a white dwarf, was discovered by multi-epoch Spitzer observations. The IRAC colors and absolute magnitudes indicate that it is a brown dwarf approximately as cold as the >=Y2 dwarf WISE 1828+2650, the coldest spectroscopically confirmed brown dwarf (Teff ~300K). WD 0806-661B is too faint for spectroscopy, so we propose to characterize this object with multi-wavelength WFC3/IR observations. The photometry will not only allow us to characterize WD 0806-661B as a cold brown dwarf, it will also provide insight into the rapidly changing J-ch2, J-H, and Y-J colors exhibited by the Y dwarfs. The observations will also help bridge the gap between "normal" Y dwarfs and the enigmatic WISE 1828+2650.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13429
Program Title: Unveiling the X-ray/UV Connection in AGN Winds: the PG 1126-041 Case Study

Principal Investigator: Margherita Giustini
PI Institution: European Space Agency - ESTEC

Winds are key to understanding the nature of AGN at small and large scales. Winds are common in AGN, and likely play a role in regulating the black hole growth and star formation in the surrounding galaxies. Models of radiatively-driven winds predict that X-ray absorbing gas acts as a shield, preventing over-ionization of the UV outflowing gas by the strong illuminating continuum source. However, recent observations are putting the hypothesis of this X-ray absorbing gas to the test.

We propose a 2-cycle small GO program of 4 HST+XMM coordinated observations with the goal of exploring the connection (if any) between the UV and X-ray absorbing wind phase(s). PG 1126-041 is a low redshift (z=0.06) luminous Seyfert 1 galaxy that displays complex and variable UV and X-ray absorption. A 1992 simultaneous IUE +ROSAT observation revealed X-ray absorption in the OVII/OVIII band, and broad blueshifted (v~-5,000 km/s) UV absorption in, at least, CIV and NV transitions. Later, independent IUE and XMM-Newton observations showed that UV and X-ray absorption is highly variable, but no more UV+X-ray simultaneous observations have been carried out since 1992. The X-ray absorbing gas could be acting as a "patchy" porous shield, and its variations in our line-of-sight could be causing the observed UV variability; if so, a correlation between UV and X-ray absorption is expected. COS observations will cover a large range of transitions, allowing the detections of changes in the ionization of the UV absorber. Our results will be a direct test of the relation between the UV and the X-ray phases of the wind, and as such will be of crucial interest to test AGN wind models.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13430
Program Title: The temperatures, masses and pulsation modes of three ZZ Cetis in the Kepler field

Principal Investigator: Sandra Greiss
PI Institution: The University of Warwick

Most stars in our Galaxy, including all known planet hosts, will end or have already ended their lives as white dwarfs, dense stellar remnants sustained by electron degeneracy. Here, we propose to obtain COS far-ultraviolet spectroscopy of three pulsating hydrogen-atmosphere (DA) white dwarfs (ZZ Ceti stars) that for which we are obtaining Kepler short-cadence data. Far-ultraviolet spectroscopy of white dwarfs, covering the H2/H2+ quasi-molecular satellites around 1400A and 1600A, is essential to determine accurate atmospheric parameters, and precision asteroseismology of white dwarfs has the potential to probe in detail the structure of their cores and envelopes that is not possible in any other way. A succesful asteroseismologial analysis requires, however, the correct identification of the pulsation modes. Because ZZ Ceti stars have typically only few large-amplitude modes, the mode identification based on their optical light curves is often ambiguous. Because the ratio of ultraviolet-to-optical pulsation amplitudes depends strongly on the

pulsatoin mode, our COS data will also enable us to identify the pulsation modes in the Kepler light curves of these three stars. The unique combination of HST and Kepler observations will enable to investigate the atmospheric and internal structure of three white dwarfs with an unprecedented accuracy. The proposed research is part of the PI's doctoral thesis.

Proposal Category:	GO
Scientific Category:	Extra Solar Planets
ID:	13431
Program Title:	The First Spectroscopic Phase Curve of a Transiting Planet: Understanding the Deeper Atmosphere
Principal Investigator:	Catherine Huitson
PI Institution:	University of Exeter

Characterization of extrasolar planets has accelerated rapidly thanks to low-density transiting hot Jupiters, which have large signals in transmission and secondary eclipse and enable the study of atmospheres in new and extreme conditions. Despite this, such observations are limited since they cannot directly be linked to physical atmospheric processes.

Phase curves are crucial because they provide information about the circulation in a planetary atmosphere by constraining the day-night temperature contrast and horizontal wind speeds. The only existing exoplanet phase curves are photometric. We propose to measure the first spectroscopic phase curve, to probe the 3D atmospheric thermal, chemical and wind structure. Unlike previous work, this will constrain degeneracies between atmospheric opacities and temperatures. We will target WASP-19b, an ideal candidate with a short orbital period, large expected signal and constrained composition.

We propose to measure the first near-IR phase curve using WFC3, to probe down to 0.4 bar, a previously unobserved regime and the deepest currently possible for thermal phase curves. WASP-19b is at the critical temperature where thermal redistribution could become less efficient. Deep-atmosphere observations, where advection should dominate, will provide the best constraints (Showman & Guillot, 2002) and will also reach down to the optical photosphere for transmission spectroscopy.

The proposed observations will extend our knowledge to 3D circulation, and constrain physical processes in a previously

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Proposal Category:	GO
Scientific Category:	Resolved Stellar Populations
ID:	13432
Program Title:	To be or not to be the progenitor: The question about Tycho-B
Principal Investigator:	Wolfgang Kerzendorf
PI Institution:	University of Toronto

Despite the importance of Type Ia SNe, we still do not know whether they result from mass transfer onto a WD from a non-degenerate companion, from the coalescence of two degenerate stars, or perhaps a from a combination of these two pathways. Here we seek to show, by identifying the donor star, that SN1572--the prototypical Galactic SN Ia reported by Tycho--resulted from the single-degenerate scenario. We know from ground-based high-resolution spectra

that many stars near the projected center of SN1572 lack the characteristics expected for a donor companion. But one of them, the unusual A-star denoted Tycho-B, exhibits fast rotation and an unusual abundance pattern of low overall metallicity ([Fe/H]~-1) yet high abundances of C and O. Tycho-B is a few arcsec from the geometric center of SN1572, and our distance estimate is consistent with that for SN1572. If Tycho-B is in fact the surviving companion, it must be located within the SNR shell. In this case, we expect it will show broad, blue-shifted absorption in Fe II from undecelerated cold ejecta that have long-since swept past the companion star, but have not yet encountered a reverse shock. We propose to use HST/STIS to obtain UV spectra that will clearly reveal such absorption. While a positive result is not guaranteed, the potential payoff of establishing Tycho-B as the donor is large. If Tycho-B is instead a background object, these spectra will still provide an important probe for the cold ejecta in SN1572, as we have done for the older Ia remnant of SN1006.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13433
Program Title: Stellar Forensics V: A post-explosion view of the progenitor of SN 2011dh

Principal Investigator: Justyn Maund
PI Institution: The Queen's University of Belfast

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 supernovae to search for clues about the nature of their progenitors.
We request time to conduct deep, late-time, high-resolution imaging with WFC3 UVIS and ACS WFC of the site of the Type IIb supernova 2011dh. The nature of the observed yellow supergiant progenitor conflicts with the predictions of stellar evolution models and our understanding of the optical and radio light curves of the subsequent supernova.
We aim to: 1) Confirm our original identification, made in pre-explosion images, by confirming that the yellow supergiant is now missing; 2) Apply image subtraction techniques for the pre-explosion images with this late-time imaging to determine accurate photometry of the progenitor to constrain its temperature and luminosity; 3) conduct a deep search for the hypothesised hot binary companion; and 4) 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 UV/optical imaging at very faint magnitudes that will facilitate this study.

Proposal Category: GO
Scientific Category: ISM and Circumstellar Matter
ID: 13434
Program Title: Transmission spectroscopy through the debris disk of Fomalhaut

Principal Investigator: Tiffany Meshkat

PI Institution: Leiden Observatory

Fomalhaut, a young nearby A4V star, is surrounded by an inclined dust debris belt, directly imaged in optical scattered light with the HST. The proper motion and parallax of Fomalhaut will move this belt across an 18th magnitude background white dwarf star in the next decade. This presents a unique and fortuitous opportunity to probe the presence of gas and dust in the debris disk through spatially resolved transmission spectroscopy. We propose obtaining an HST/COS spectrum of the absorption during the diffuse (Cycle-21), thick (Cycle-23), and pristine (~2021) phase of occultation as the debris disk moves across the target background source. This is a rare opportunity to measure - for the first time - refractory elements and dust properties in a known planet-forming system, providing a valuable constraint on current planet formation theories. This experiment will act as a pathfinder for this type of science for future observations with JWST and future ELTs.

Proposal Category: GO

Scientific Category: Resolved Stellar Populations

ID: 13435

Program Title: Multiple populations in external globular glusters: the Fornax dSph, the LMC, and the SMC

Principal Investigator: Matteo Monelli

PI Institution: Instituto de Astrofisica de Canarias

The fact that the vast majority, if not all, Galactic globular clusters (GCs) host multiple stellar populations is nowadays commonsly accepted, thanks to a well settled observational scenario. Nevertheless, these are relatively recent findings, that brushed away the classical idea that GCs are the closest approximation of simple stellar populations, formed by coeval and chemically homogeneous stars. Since GCs are among the oldest structures formed in the Universe, and are relics of the first epochs of assembling of galaxies, and in particular of our Milky Way, understanding how GCs formed and their early evolution is important to shed light on giant galaxies formation. However, so far multiple populations have been searched only in Galactic old (> 10 Gyr) GCs. With this project we propose to extend such search to old clusters in nearby dwarf galaxies: the Fornax dSph, the LMC and the SMC. This will provide a valuable data set to compare with a ground base data for a large number of Galactic GCs collected by our group in the framework of the SUMO project. The main aim of this project is to verify if multiple populations exist in the GCs of these low mass galaxies, and to verify if their properties are similar to Galactic ones, or if the environment plays a significant role.

Proposal Category: GO

Scientific Category: ISM and Circumstellar Matter

ID: 13436

Program Title: Ion Temperatures in a Collisionless Supernove Remnant Shock Wave

Principal Investigator: John Raymond

PI Institution: Smithsonian Institution Astrophysical Observatory

Electrons, protons and heavy ions can all have different temperatures behind a collisionless shock. The temperatures are important for understanding the physics of the shock and for correctly interpreting observations in terms of shock parameters. They also bear upon the acceleration of different species in the Cosmic Ray population. We propose to obtain a deep enough integration to measure the kinetic temperatures of C IV and He II in a 350 km/s non-radiative shock in the northern Cygnus Loop where we have extensive complementary H alpha and X-ray data.

Proposal Category: GO

Scientific Category: Cosmology

ID: 13437

Program Title: The Morphology and Star Formation Distribution in a Big Cool Spiral LIRG

Principal Investigator: Jane Rigby

PI Institution: NASA Goddard Space Flight Center

Evidence from both the SEDs and morphologies of vigorous starbursts at z~1 compared to local templates shows that the mode of star formation in these galaxies is distinctly different in the past compared to the present day. Locally these objects (luminous infrared galaxies - LIRGs) show compact nuclear star forming regions with hot dusty SEDs; distant objects of similar luminosity appear much cooler and show signs of star formation over much larger regions. At z~1 these galaxies dominate the star formation rate density; they are where most stars are being formed, and so studying these sources is critical to understanding the overall picture of galaxy evolution. In a recent paper we detail the discovery of SGAS1438+1454, a lensed LIRG at z=0.816 that allows us to confirm this evolution of the mode of star formation in distant LIRGS in unprecedented detail. The lensed galaxy is a typical z~1 LIRG. With imaging data from g-band to 500 microns, and both optical and near-IR spectra in hand, we now seek to cap these extensive observations with a modest 3 orbit observation with HST. From the proposed data we will confirm the morphology and exent of the source with multi-band imaging, and directly measure the detailed distribution of star formation with an H-alpha grism observation. Extensive work shows that z~1 LIRGS are very different than today; with this lensed (but otherwise typical) LIRG and HST we will begin to illuminate how and why this difference exists.

Proposal Category: GO
Scientific Category: Solar System
ID: 13438
Program Title: Probing the atmosphere of a transiting ocean world

Principal Investigator: William Sparks

PI Institution: Space Telescope Science Institute

We propose to image the atmosphere of Europa against the smooth FUV and NUV background of Jupiter to reveal or constrain its structure, scale height and composition. Molecules are liberated from the surface by a combination of sputtering and erosion associated with impacting magnetospheric ions, micrometeroids, sublimation from sunlight and, potentially, cryogenic volcanism. In detail, the relationships between the atmosphere, exosphere and surface are not understood. The clumpy FUV OI emission implies a patchy, irregular exosphere, suggestive of localized sources and strong atmospheric density variations. If the internal heat sources and surface cracking are sufficient to release outgassing plumes, as for Enceladus, we have an excellent chance of detecting them. By using the STIS FUV MAMA TIME-TAG imaging: Jupiter is smooth, detector features are removed, and we can crisply image, post-facto, any and all targets in the field individually, including Europa, its shadow and features on Jupiter. The spatial resolution is highest in the FUV and cross-sections of relevant molecules are high. An intriguing archival image demonstrates the power of this approach. An additional observation in the NUV using conventional CCD imaging will provide sensitive limits on dusty particulates above the surface, potentially entrained by outflowing gas.

Proposal Category: GO
Scientific Category: ISM in External Galaxies
ID: 13439
Program Title: Gas Physics in Cool-Core Clusters: the Virgo Cluster

Principal Investigator: William Sparks

PI Institution: Space Telescope Science Institute

We have detected and confirmed the presence of high temperature gas at 10^5K associated with the low excitation 10^4K line emission filaments of M87. This is a profoundly important observation bearing on the physics of transport processes in cool-core clusters, mergers and feedback from AGN into the surrounding ISM. We propose to obtain a deep FUV COS spectrum in order to (1) detect lines that are characteristic of gas at a wide range of temperatures and (2) measure the FUV CIV and HeII line widths and velocity. The additional emission lines will allow us to empirically determine the temperature distribution across the critical region between 10^4K ("optical") and 10^7K ("X-ray") in the filament and understand how these two very different components of the ISM are connected, and which theoretical scenario is viable. The line widths and velocity further offer a direct discrimination between competing physical processes that include turbulence, condensation and evaporation - observationally broadening, inflow and outflow respectively. We will also acquire a two orbit ACS/SBC image to image the HeII line, which has a higher mean emission temperature than CIV, in isolation from CIV. In conjunction with our existing FUV deep image, we will be able to study the structure of the filaments in these two lines, and hence reveal the character of spatial variations of the interface between hot and cool gas.

Proposal Category:	GO
Scientific Category:	Cosmology
ID:	13440
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 offer a unique tracer of early star formation and the galaxy populations in the era of reionization. Our efforts to identify high-z GRBs haev been rewarded with the discoveries of GRB 090423 and GRB 120923A at spectroscopic redshifts of 8.2 and 8.5 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 difficult regions of the IR spectrum. 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. Our proposal aims to increase the efficiency of locating z>7 GRBs by performing such spectroscopy on up to two candidates for which photometry suggests they are very high-z, 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 high-z GRBs leads us to request a two-cycle ToO program, spanning cycles 21 and 22.

Proposal Category:	GO
Scientific Category:	ISM and Circumstellar Matter
ID:	13441
Program Title:	Co-latitudinal Radial Veloctiy Profile Confirmation Via Differential Proper Motion of the Bipolar Egg Nebula
Principal Investigator:	Rachael Tomasino
PI Institution:	University of Denver

Requesting the use of ACS/WFC for one orbit to obtain a deep 3rd epoch exposure of the Cygnus Egg Nebula. The proposed observation of the Egg will not only yield multi-epoch snapshots of the circumstellar arcs but also determine the co-latitudinal velocity field that helps break the degeneracy in model fitting. Full 3-D model calculations, done by Col Kim, have already quantified the co-latitudinal dependence due to the binary orbital motion, relating the orbital speed of the binary stars to the resulting structural pattern in the circumstellar density distributions. We will be able to constrain the orbital properties of the Egg Nebula via a new set of specific model fitting. The duplication of the epoch 2 observation (PI: W. Sparks) is by design and with a baseline between the 2nd and 3rd epoch of more than 11 years, there is a lower limit shift of 1.32 pixels for the slower moving arcs and it will be more than enough to perform a differential proper-motion study. The Cygnus Egg Nebula is a proto-planetary nebula, which means that the

circumstellar density structure still retains valuable clues pertaining to the early asymptotic giant branch mass loss history and initial development of their aspherical shell structure. One of the most peculiar characteristics of the circumstellar shell structure of the Egg Nebula is the co-presence of the nebula's signature bipolar lobes and rather circular concentric arcs superposed on top of each other. There is no consensus among researchers on their origins, especially because of the paradox due to the co-presence of the circular arcs and bipolar lobes.

Proposal Category: SNAP
Scientific Category: Resolved Stellar Populations
ID: 13442
Program Title: The Geometry and Kinematics of the Local Volume

Principal Investigator: R. Tully
PI Institution: University of Hawaii

HST is uniquely capable of providing distances to nearby galaxies through measurement of the luminosities of stars at the Tip of the Red Giant Branch (TRGB). With accurate distances, we generate three-dimensional maps of the distribution of galaxies and decouple the expansion and peculiar components of line-of-sight velocities. Essentially all galaxies have RGB stars and the halo populations are free of host reddening. With a single orbit ACS observation in two filters a color-magnitude diagram can be constructed that reaches 1.4 mag fainter than the TRGB for a galaxy at 8 Mpc. The tremendous efficiency and accuracy of the TRGB method makes it possible to observe a large, complete volume-limited sample with a modest allocation of HST resources. Presently in the archives there is material that gives good coverage to ~4 Mpc. It is now proposed to draw randomly from a complete sample of all unobscured (A_B < 0.5) galaxies brighter than M_B = -12 within 7 Mpc and to probe with additional sparse sampling to 10 Mpc. Our immediate interests are (a) to study in detail the clustering properties of galaxies with distance resolution of 200 kpc, and (b) to map the local velocity field as a probe of the distribution of dark matter and dark energy. In addition, the program will provide an archival legacy of the stellar content of nearby galaxies to a level in the color-magnitude diagram at least as faint as M_I = -2.6.

Proposal Category: GO
Scientific Category: Resolved Stellar Populations
ID: 13443
Program Title: Proper Motions along the Orphan Stream: Finding the Parent, Orbit, and Milky Way Halo Shape

Principal Investigator: Roeland van der Marel
PI Institution: Space Telescope Science Institute

Stellar streams in the Milky Way (MW) support the view that much of its halo was formed hierarchically via the tidal disruption of dwarf galaxies and globular clusters. These streams are unique dynamical tracers of the dark matter halo, and provide strong tests of galaxy formation models. The Orphan Stream, discovered in the SDSS survey area, is closer, colder, and fainter than the better known Sagittarius (Sgr) Stream, and it has no known parent galaxy. It therefore

allows a study of the less-massive objects that built up the MW halo. Lack of proper motion (PM) data limits our understanding of stream orbits and MW dark halo properties. HST's excellent astrometric accuracy can now address this, as demonstrated by our ongoing Sgr Stream study. We propose here to map the PM variation along the Orphan Stream. We will target four fields with ACS/WFC for which serendipitous first-epoch observations exist in the Archive with 10-12 yr time baselines. PM accuracies near 6 km/s will be achieved by measuring the relative motion between stream stars and background galaxies, using techniques developed by us for other successful PM programs (e.g., LMC/SMC, Leo I, M31). We will interpret the results using dynamical calculations and N-body models, using our techniques already developed for modeling the Sgr and Magellanic Streams. Our study will yield the orbit of the Orphan Stream, which in turn may allow us to identify its progenitor (if not already entirely disrupted). The orbit will also strongly constrain the shape and mass of the MW dark halo, especially when combined with our ongoing studies of other streams.

Proposal Category:	GO
Scientific Category:	Quasar Absorption Lines
ID:	13444
Program Title:	Constraining the size of intergalactic clouds with QSO pairs
Principal Investigator:	Bart Wakker
PI Institution:	University of Wisconsin - Madison

This proposal aims at a geometric estimate of the size of intergalactic absorbers (clouds) near redshift 0, which make up the 10^4 K photoionized phase of the intergalactic medium (IGM). Theoretically the size of these clouds is expected to be ~170 kpc at log N(HI)=13.3 and ~20 kpc at log N(HI)=16. So far, this has only be tested observationally for a few rare systems in which metal-line absorption allows photoionization modeling. We propose to observe 4 QSO pairs (7 new QSOs and 1 archival dataset) separated by 2 to 5 arcmin (corresponding to ~20 kpc at cz=1500 km/s). Using these data we can set a completely independent, geometrical, constraint on the cloud sizes, even if no metal lines are seen. The data will further allow determining velocity gradients in single clouds.

Proposal Category:	GO
Scientific Category:	Cosmology
ID:	13445
Program Title:	Absolute Calibration of the Extragalactic Mira Period-Luminosity Relation
Principal Investigator:	Joshua Bloom

PI Institution: University of California - Berkeley

In this era of precision measurement of the parameters of the cosmological equation of state, constraining the present-day value of the Hubble constant remains a vital endeavor: uncertainties in H_0 couple directly to imprecision in the matter and dark energy contributions to the evolution of the universe (e.g., w, and w1). Starting with the HST Key Project more than a decade ago, the uncertainty in H_0 has been cut from over 10% to something approaching 3%. A major advance was made recently, leapfrogging Milky Way calibrations, by directly anchoring the infrared Cepheid Period-Luminosity (PL) relation to NGC 4258, the famous megamaser galaxy with a highly precise geometric distance. We propose to anchor the infrared PL relation of Mira variables to NGC 4258, providing the first-ever absolute extragalactic PL relation of such stars, opening a new avenue for precision H_0 efforts. In the infrared, Miras are comparable in absolute magnitude to Cepheids, and thus are direct complements to Cepheids within the same volume (up to ~25 Mpc). The principal advantage of Miras, however, is that they are ~20 times more numerous than Cepheids. Thus, a Mira-focused distance measurement study can cover 5% of the surface area of a Cepheid-focused study and achieve a comparable distance measurement accuracy. Over the 12 proposed visits with WFC3/F160W (and 1 with WFC3/F125W), and coupled with previous observations of the field, we expect to discover and characterize ~1000 Miras, accurately identifying periods <~ 550 days. This investment now should demonstrate significant observing efficiency increases for JWST if indeed Miras are found to be an acceptable replacement to Cepheids.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13446
Program Title: Massive Stars and their Siblings: the Extreme End of the Companion Mass Function

Principal Investigator: Selma de Mink

PI Institution: Space Telescope Science Institute

The gold-rush for detecting exoplanets has lead to an exponential improvement of optimization algorithms for high-contrast imaging optimized for HST. We propose to exploit these to probe the virtually unexplored population of low mass stars in the very close vicinity of young massive stars in order to

I. progress our understanding of how low-mass stars form and survive under the influence of the ionizing radiation of their massive host and
II. provide urgently needed constraints on competing theories of massive star formation by measuring their multiplicity.

The high spatial and temporal stability of HST's point spread function is essential for the detection of very faint companions down to sub-arcsecond separations even in crowded regions at contrast up to delta-mag ~ 10, i.e. flux ratios up to 10,000. Furthermore the characterization of the low mass companions calls for wavelength bands largely affected by absorption by H2O in the earth's atmosphere. To achieve this goal we propose to use WFC3/IR to observe two adjacent fields in the center of the very young, nearby star cluster Trumpler 14, which harbors a rich population of massive stars.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13447

Program Title: The massive monsters living deep in the Tarantula nebula: How massive are they really?

Principal Investigator: Selma de Mink

PI Institution: Space Telescope Science Institute

The recent suggestion that stars with masses in excess of about 300 solar masses exist in the dense star cluster R136 at heart of the Tarantula Nebula received wide interest. It reopened the debate about the upper stellar-mass limit of the initial mass function (IMF) and it raised the question whether pair-instability supernovae -- originally thought exclusively originate from first generation of pop III stars -- can occur in the vicinity of Milky Way.

A major challenge hampering mass estimates of the most massive stars is crowding and unresolved companions. High-resolution imaging from the ground and with HST reaching resolutions of about 0.1 arcsec resolved the brightest source in R136 into three separate components. Unfortunately, the extreme crowding and faintness of the targets prohibits ground-based facilities to reach further towards mili-arcsecond resolution.

We propose to exploit the new full two-dimensional calibration program of Fine Guidance Sensor (Nelan, id 13175) to probe the most luminous stars in R136 for previously unseen companions down to a resolution of 12 mili-arsecond, exploring the separation of about 500-5000 AU. Furthermore, we will characterize the claimed source R136-a1B and if needed revise downward the mass estimates of the most massive stars known date.

Proposal Category: GO

Scientific Category: ISM and Circumstellar Matter

ID: 13448

Program Title: The Closest Galactic Wind: UV Properties of the Milky Way's Nuclear Outflow

Principal Investigator: Andrew Fox

PI Institution: Space Telescope Science Institute - ESA

Like other spiral galaxies, the Milky Way drives a biconical nuclear wind. This outflow is visible in emission in many parts of the electromagnetic spectrum, including spectacular Fermi gamma-ray bubbles and radio lobes extending to ~10 kpc above and below the Galactic Center. The nuclear wind is thought to be powered by either the central black hole or high-surface-density star formation, but our understanding is hampered by a lack of kinematic information. We propose a comprehensive spectroscopic program to survey the nuclear outflow in both the northern and southern Galactic hemispheres. This program combines high-resolution STIS E140M observations of six distant halo stars at low latitude with medium-resolution COS observations of 10 AGN at higher latitude. The halo-star spectra will constrain the plasma density distribution (mid-plane density and scale height of C IV, Si IV, and N V absorption) of the low halo within a few kpc of the plane, where the outflow is thought to be launched. The AGN spectra will provide crucial kinematic and ionization information on the outflow away from the plane, allowing us to determine (i) how far the high-ion wind extends, (ii) whether the outflow is accelerating or decelerating, and (iii) the ionization mechanism in the outflow. This dataset will also reveal the relationship between the UV-absorbing gas and the other phases of the wind, which will aid the understanding of outflows from other galaxies and galaxy nuclei.

The unique UV capability of HST is essential to this program.

Proposal Category: GO
Scientific Category: Resolved Stellar Populations
ID: 13449
Program Title: A Non-Universal Initial Mass Function in the Ultra-Faint Galaxy Coma Berenices

Principal Investigator: Marla Geha
PI Institution: Yale University

The stellar initial mass function (IMF) underlies all estimates of galaxy stellar masses and star formation histories. There are theoretical reasons and indirect observations to suggest that the IMF varies with galactic environment. We recently demonstrated via main sequence star counts that the Milky Way ultra-faint dwarf galaxies have shallower IMF slopes as compared to the Milky Way over the mass range 0.5 - 0.75 M_sun, providing direct evidence that the IMF depends on galactic environment. However, these observations do not reach the stellar mass at which the IMF in the Milky Way turns over. Determining the presence and location of an IMF turn over in an environment distinct from the Milky Way will directly test theories of low mass star formation and have implications at all galaxy mass scales. We propose to measure the IMF in the ultra-faint dwarf galaxy Coma Berenices, one of the least luminous and most metal-poor galaxies known. Using the WFC3, we will measure the shape of the IMF to a stellar mass of 0.17 M_sun. This extremely low mass limit is enabled by the combination of ComBer's proximity (44 kpc) and WFC3's infrared sensitivity to the light from such cool stars. The proposed observations represent a unique opportunity to cleanly determine the IMF in a significantly different environment than previously possible and will be the deepest direct IMF measurement outside the Milky Way.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13450
Program Title: Separating the Spectral Components of the Massive Triple Star System Delta Orionis

Principal Investigator: Douglas Gies
PI Institution: Georgia State University Research Foundation

The multiple star system of delta Orionis represents one of the closest examples of a luminous O-star with a strong stellar wind, and it was the target of a recent multi-wavelength campaign to determine the source of the wind X-ray emission. It consists of a close eclipsing binary with a more distant tertiary, and all the components are massive stars. Investigations of the radial velocity curves of the eclipsing system are made difficult by severe line blending with the spectral lines of the tertiary star, and the resulting mass estimates range by a factor of two. We propose that the solution to this problem is to isolate the flux of the tertiary through high angular resolution spectroscopy with HST/STIS, and we show how a two visit program of ultraviolet and spatially resolved spectroscopy will provide us with the means to characterize the spectra of all three stars in the triple. This will allow us to reassess a large body of existing optical and UV spectroscopy and determine reliable radial velocity curves for the components in the close binary. By then fitting a new high precision light curve from MOST photometry, we will derive accurate masses, temperatures, radii,

and projected rotational velocities for all the components. The inner binary also has a measured apsidal period, and the new results will form a key test of models of interior structure. The analysis will also provide secure estimates for the geometry and size of the inner binary and the radius of the secondary, the parameters required to analyze the orbital phase variations and sites of origin of the wind X-ray emission

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Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13451
Program Title: A Study of PG Quasar-Driven Outflows with COS

Principal Investigator: Frederick Hamann

PI Institution: University of Florida

Quasar outflows are an important part of the quasar phenomenon, but many questions remain about their energetics, physical properties and the role they might play in providing feedback to host galaxy evolution. We searched our own COS far-UV observations from the QUEST survey and other large COS programs to find a sample of 6 bright PG quasars with broad (FWHM > 400 km/s) high velocity (v > 1000 km/s) absorption lines that clearly form in quasar-driven winds. These quasars can fill an important gap in our understanding between local Seyferts with low-speed winds and high-redshift quasars with extreme BAL outflows. They are also well-studied at other wavelengths, with some evidence for the quasars driving galaxy-scale blowouts and shutting down star formation. But almost nothing is known about the quasar outflows themselves.

We propose a detailed study of these 6 outflow quasars using new COS FUV observations to 1) expand the existing wavelength coverage across critical lines that are diagnostic of the outflow physical conditions, kinetic energies, and metallicities, and 2) check for line variability as an indicator of the outflow structure and locations. This quasar sample includes unusual cases with many low-abundance (PV 1118,1128 and SIV 1063) and excited-state lines (SIV 1073*, CIII* 1175, CII* 1335) that will provide unprecedented constraints on the outflow properties, plus the first known OVI-only mini-BAL outflow (no lower ions detected) for which we will cover NeVIII 770,780 to probe the highest ionization gas. The high FUV sensitivity of COS is uniquely able to measure this wide range of outflow lines in low-redshift quasars with no Lya forest contamination.

Proposal Category: GO
Scientific Category: ISM in External Galaxies
ID: 13452
Program Title: Coupling the emission of ionizing radiation and Lyman alpha

Principal Investigator: Matthew Hayes

PI Institution: Observatoire Midi-Pyrenees

The class of objects that reionized intergalactic hydrogen remains an observational and theoretical problem that is in contention for being the most prominent puzzle piece in contemporary astrophysics. The current consensus - determined almost entirely by ruling out bright active galaxies - is that the process was possibly begun and almost certainly finished by faint, lower-mass galaxies forming their early generations of stars. Recent observations of z~3 galaxies may even have identified the analog populations.

However understanding how the emitted ionizing power of galaxies is causally related to their (robustly determined) physical properties is not a study that can be performed at high-z: neither the spatial information nor the standard multi-wavelength diagnostics are available. Moreover, on a case-by-case basis, the intervening IGM absorption is

impossible to determine. These considerations have spawned a number of detailed studies with UV space telescopes, the synthesis of which however is that a characteristic population of Lyman continuum (LyC) emitting objects has not yet been identified. We show in this proposal that we have identified a characteristic trait in galaxy spectra that is highly indicative of LyC emission, by combining (a) high-z phenomenological studies, (b) new high-resolution UV spectra of local galaxies, and (c) sophisticated models of radiation transport. Believing that we have determined the signature, we propose to test the new hypothesis with deep spectroscopic observations with HST/COS under the Cycle 21 UV initiative.

Proposal Category: GO
Scientific Category: Extra Solar Planets
ID: 13453
Program Title: The Elemental Compositions of Extrasolar Minor Planets

Principal Investigator: Michael Jura
PI Institution: University of California - Los Angeles

We propose to observe five white dwarfs known to be polluted by accretion of their own asteroids in order to investigate three related questions. (1) What determines carbon abundances within extrasolar asteroids? (2) Can we identify water-rich extrasolar planetesimals? (3) Can we find evidence for silicon-rich planetesimals, as would be expected if they are largely composed of crustal material? Data from these 5 proposed targets combined with previous COS observations either by ourselves or others of 6 additional targets, will complete an ultraviolet spectroscopic mini-survey of all known highly polluted white dwarfs with helium-dominated atmospheres within 80 pc of the Sun. This study will provide a unique legacy for understanding the formation and evolution of extrasolar rocky planets.

Proposal Category: GO
Scientific Category: Cool Stars
ID: 13454
Program Title: The parallax and mass of the binary classical Cepheid V1334 Cyg

Principal Investigator: Pierre Kervella
PI Institution: Observatoire de Paris

V1334 Cyg is a short-period classical Cepheid, and the primary star ("A") of a binary system. Using the CHARA interferometer, we spatially resolved its companion ("B") for the first time at an angular separation of 8 mas (Gallenne et al. 2013). Our two epochs clearly show the orbital displacement of B on its 5.3-year orbit, relative to the Cepheid, with an astrometric accuracy of 30 microas. This observation opens the exciting opportunity to determine the orbital

parallax of this system.
Based on the existing long-term radial velocimetry of A, and our interferometric data, we already derived the main orbital parameters of the system. However, we face a degeneracy between the mass ratio of the two stars and the distance. We miss the radial velocity of B (V1334 Cyg is still an SB1) or the orbital trajectory of the Cepheid around the center-of-mass. To waive this degeneracy, we request FGS astrometry and STIS high resolution spectroscopy. The FGS observations will trace the apparent orbital trajectory of A on the sky (to 0.1 mas accuracy), and the high-resolution STIS spectroscopy will give us the radial velocity of B (to < 1 km/s). The spectral disentangling of A and B is impossible in the visible due to the high contrast between A and B in this wavelength domain. In the UV, the companion flux dominates the Cepheid, thanks to its early spectral type (~B5V), and the disentangling is a lot easier.
Combining STIS and FGS with CHARA interferometry, our goal is to obtain in 3 years the parallax and mass of the Cepheid with an unbiased accuracy of 1%. This will set a solid fiducial point for the calibration of fundamental Cepheid relations (period-luminosity, mass-period,...).

Proposal Category:	GO
Scientific Category:	Debris Disks
ID:	13455
Program Title:	The Eccentric Debris Ring Around HD 202628: Signs of Planetary Perturbations
Principal Investigator:	John Krist
PI Institution:	Jet Propulsion Laboratory

Debris disks are the signposts of planetary systems: collisions among asteroidal and cometary parent bodies maintain the observed dust population against losses to radiation pressure, stellar wind, and P-R drag. Disk images establish the size scale of an exoplanetary system. They can reveal central holes, rings, gaps, warps, and asymmetries in the dust distribution that indicate the presence of planetary perturbers. In 2011 we discovered a large debris disk in HST coronagraphic images. HD 202628's disk is an eccentric ring with a sharp inner edge and cleared central zone - only the third such system ever imaged, and with the faintest surface brightness ever for a disk seen in scattered light. Key differences for this object are its larger ring diameter and eccentricity, and the solar-type of the host star. The discovery image represents only two orbits of integration and suffers from low overall signal to noise. We propose a series of deeper imaging observations with the STIS coronagraph over multiple roll angles. Important parameters of the ring to be clarified by the new data are the sharpness of the ring inner edge, its outermost radial extent, and the strength of radial/azimuthal brightness density gradients. From these we can derive constraints on the mass and orbit of the perturbing planet. The outcome of our program will be the best evidence to date for a distant planetary companion to a sun-like star.

Proposal Category:	GO
Scientific Category:	ISM in External Galaxies
ID:	13456
Program Title:	Searching for 300,000 Degree Gas in the Core of the Phoenix Cluster with HST-COS
Principal Investigator:	Michael McDonald

PI Institution: Massachusetts Institute of Technology

The high central density of the intracluster medium in some galaxy clusters suggests that the hot 10^7K gas should cool completely in less than a Hubble time. In these clusters, simple cooling models predict 100-1000 Msun/yr of cooling gas should fuel massive starbursts in the central galaxy. The fact that the typical central cluster galaxy is a massive, "red and dead" elliptical galaxy, with little evidence for a cool ISM, has led to the realization of the "cooling flow problem". It is now thought that mechanical feedback from the central supermassive blackhole, in the form of radio-blown bubbles, is offsetting cooling, leading to an exceptionally precise (residuals of <10%) balance between cooling and feedback in nearly every galaxy cluster in the local Universe. In the recently-discovered Phoenix cluster, (z=0.596), we observe an 800 Msun/yr starburst within the central galaxy which accounts for ~30% of the classical cooling prediction for this system. We speculate that this may represent the first "true" cooling flow, with the factor of 3 difference between cooling and star formation being attributed to star formation efficiency, rather than a problem with cooling. In order to test these predictions, we propose far-UV spectroscopic observations of the OVI 1032A emission line, which probes 10^5.5K gas, in the central galaxy of the Phoenix cluster. If detected at the expected levels, this would provide compelling evidence that the starburst is, indeed, fueled by runaway cooling of the intracluster medium, confirming the presence of the first, bonafide cooling flow.

Proposal Category: GO

Scientific Category: Cool Stars

ID: 13457

Program Title: Accurate Mass Determination of the Nearby Old White Dwarf Stein 2051B through Astrometric Microlensing

Principal Investigator: Kailash Sahu

PI Institution: Space Telescope Science Institute

The very nearby and well-known cool white dwarf (WD) Stein 2051B will pass very close to a 19.5-mag background star in March 2014, with an impact parameter of <0.2 arcsec. This affords a unique opportunity for a direct determination of its mass, through measurement of the gravitational deflection of the background star's image.

As it passes in front, Stein 2051B will cause a deflection of the background star's image by ~3 milliarcsec, an amount detectable at the ~10-sigma level with HST/WFC3. The gravitational deflection angle depends only on the distances and relative positions of the stars, and on the mass of the WD. Since the distances and positions can be determined precisely before the event, the astrometric measurement offers a unique and direct method to measure the mass of the WD to high accuracy (<5%).

One key astrophysical prediction for WDs is the existence of a mass-radius relation, which depends primarily on the core composition of the WD. Since the radius of Stein 2051B is known (from its distance, luminosity, and effective temperature), our mass measurement will provide an important addition to the very small number of WDs with well-determined radii and masses. The mass of Stein 2051B is of special interest because it is an old and relatively massive WD.

Proposal Category: GO

Scientific Category: Hot Stars

ID: 13458

Program Title: Detecting Isolated Black Holes through Astrometric Microlensing

Principal Investigator: Kailash Sahu

PI Institution: Space Telescope Science Institute

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

The only technique available to detect such isolated BHs is astrometric microlensing---the relativistic deflection of light from background stars. HST is the only instrument currently capable of detecting such tiny deflections.

We have underway a multi-year program of HST high-precision astrometry of long-duration microlensing events in the Galactic bulge, using the WFC3 camera. Our aim is the first detection of stellar-mass black holes, by monitoring five optimally selected events.

Our program has met with success, with clear detections of motions during microlensing, indicative of non-luminous massive lenses. However, proper motions of the stars in the Galactic bulge can be of similar magnitude as the deflections due to microlensing. Fortunately, the proper motions are linear whereas the deflections due to microlensing are not, but it is clearly important to accurately subtract the proper motions. The time baseline of our observations is inadequate for 4 of the 5 microlensing events that we are monitoring, since the expected lensing signal was substantial until now. We have completed observations for one, but need 2 additional observations each for the 4 remaining events in order to accurately determine their proper motions. This will lead to a robust determination of the lens masses, thus completing the original objectives of the program.

Proposal Category: GO

Scientific Category: Cosmology

ID: 13459

Program Title: The Grism Lens-Amplified Survey from Space (GLASS)

Principal Investigator: Tommaso Treu

PI Institution: University of California - Santa Barbara

How did galaxies reionize the universe (if they did)? Why is galaxy evolution environment dependent? How do gas and metals cycle in and out of galaxies? GLASS will address these fundamental questions by taking WFC3 near-infrared integral field spectroscopy of 10 clusters with extensive HST imaging from CLASH and the Frontier Field initiative. Assisted by lensing magnification, our carefully designed strategy will improve line sensitivity by an order of magnitude over current HST near-infrared spectroscopic surveys. GLASS will address question 1 by providing spectra of ~170 Lyman break galaxies at z>6, and detecting Lyman alpha in ~30 of them at 6<z<7 and ~12 at 7<z<8.5. GLASS will also provide the first information on the size of Lyman alpha emitters at these redshifts. GLASS will address question 2 by providing the first comprehensive and unbiased census of spatially resolved star formation in cluster galaxies beyond the local universe. The ~400 Halpha detections will provide a new window on the mechanisms that regulate star formation and morphological transformation in dense environments. ACS grism parallels will provide equivalent information for ~300 galaxies in the cluster infall regions. For question 3, GLASS will detect thousands of background emission line galaxies and measure spatially resolved star formation and metallicity indicators in 150-300 of them at 1.3<z<2.3. Reduced HST grism spectra and ground based optical spectra resulting from coordinated campaigns will be made public to enhance the legacy value of this proposal.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13460
Program Title: The Remarkable Ultraviolet Spectrum of Mrk 231

Principal Investigator: Sylvain Veilleux
PI Institution: University of Maryland

In recent years, Mrk 231, the nearest quasar, has become the archetype of quasar feedback in action. A powerful galactic-scale wind with outflow velocity > 1000 km/sec and mass outflow rate > 400 Msun/yr has been discovered by members of our team in the optical as well as in the far-infrared (Herschel) and mm-wave (IRAM). This object was recently observed by our team with COS. The FUV spectrum of Mrk 231 is truly remarkable: Ly-alpha is in emission, faint, very broad (>10000 km/s), and highly blueshifted (-3500 km/sec). Equally remarkable are the absence of broad absorption line (BAL) features and the slowly declining FUV continuum at shorter wavelengths. Both of these results are unexpected because Mrk 231 is a well-known FeLoBAL QSO and is very dusty. This suggests that the observed Ly-alpha emission is produced in the outflowing BAL cloud system, while the Balmer lines arise primarily from the standard broad emission line region (BELR) seen through the dusty (A_V ~ 7 mag.) broad absorption line region (BALR). At present, two simple geometries - spherical and disk - may explain these data. Better measurements over the full suite of BALs in the UV are needed to better constrain these geometric models and allow us to do a quantitative analysis of the ionization, total column density, and ultimately kinetic energy of the outflow seen in the visible. We request 7 orbits to observe Mrk 231 in the FUV with COS and in the NUV with STIS. This modest investment will help us understand arguably one of the most important objects in the local universe, and shed light on the long-standing issues of the BELR geometry (disk vs wind) and outflowing BALR structure and energetics.

Proposal Category: GO
Scientific Category: Resolved Stellar Populations
ID: 13461
Program Title: The Influence of Environment on Star Forming Disks

Principal Investigator: Benjamin Williams
PI Institution: University of Washington

We propose two single-orbit pointings in the outer NGC 300 disk to extend our measurements of the evolution of the disk structure from 4 scale lengths to 12 scale lengths, matching the radial coverage for the 2 other nearby bulgeless spiral disks, M33 and NGC 2403. With these data, we can measure the star formation rate density to levels well below those probed by GALEX, and we can measure radial trends for different stellar populations. These measurements will distinguish the role of environment in warping the NGC 300 gas disk and will test our tentative result from available HST data that the evolution of the NGC 300 disk mimics that of NGC 2403 and is distinct from that of M33. This result, awaiting confirmation with resolved stellar photometry of the NGC 300 outer disk, suggests that the relatively isolated environments of NGC 2403 and NGC 300 have resulted in significantly different disk structure evolution for galaxies of very similar mass, metallicity, star formation rate, and morphology.

Proposal Category: GO
Scientific Category: Cool Stars
ID: 13462
Program Title: Tracking the Winds of Red Giants from the Star to the ISM

Principal Investigator: Brian Wood

PI Institution: Naval Research Laboratory

We propose to study the stellar winds of nine red giants from their origins near the stellar surface all the way to their merger with the ambient ISM. We will do so by studying absorption features in UV emission lines observed with STIS. The STIS spectra will include many broad absorption lines from the stellar wind. We expect that at least some of the spectra will also show narrow astrospheric absorption from the wind-ISM interaction, like that which has been observed in the Mg II h & k lines of Alpha Tau (K5 III). The astrospheric absorption will be used to study the nature of the wind-ISM collision, and will also be used as an in situ probe of ISM properties in the Local Bubble.

Proposal Category: GO
Scientific Category: Extra Solar Planets
ID: 13467
Program Title: Follow The Water: The Ultimate WFC3 Exoplanet Atmosphere Survey

Principal Investigator: Jacob Bean

PI Institution: University of Chicago

Recent surveys have revealed an amazing, and yet unexplained, diversity of planets orbiting other stars. Studying the atmospheres of representative exoplanets is the key next step in leveraging these detections to further transform our understanding of planet formation and planetary physics. This is because a planet's atmosphere is a fossil record of its primordial origins and controls its size and appearance.

We propose an intensive and comprehensive exoplanet atmosphere Large Treasury survey using the unrivaled capabilities of the WFC3 IR instrument to measure high-precision transmission, dayside emission, and phase-resolved emission spectra over a broad wavelength range for eight planetary Rosetta Stones. These data will yield unprecedented constraints on the abundances of water, elemental abundance ratios, thermal profiles, chemistries,

presence of clouds and hazes, and dynamics of exoplanet atmospheres.

Just detecting the atmospheres of these planets is not enough anymore. Revealing the fundamental properties of exoplanet atmospheres to investigate their nature and origins requires high-precision spectroscopy that is sensitive to spectral features from multiple chemical species and altitudes, and such data can only be obtained with an intensive HST program. A survey is mandatory to put the individual objects in a broader context, and to get at the underlying physics that results in a diverse array of emergent properties. This Treasury program will have no proprietary period in order to accelerate the progress of the field. This program is urgently needed to prepare for the future characterization of habitable exoplanets using JWST.

Proposal Category: GO
Scientific Category: Cool Stars
ID: 13468
Program Title: HST Observations of Astrophysically Important Visual Binaries

Principal Investigator: Howard Bond

PI Institution: Space Telescope Science Institute

We propose to continue our long-term program of astrometry of close visual binaries, with the primary goal of determining purely dynamical masses for 3 important main-sequence stars and 9 white dwarfs (WDs). A secondary aim is to set limits on third bodies in the systems down to planetary mass. Three of our targets are naked-eye stars with much fainter companions that are extremely difficult to image from the ground. Our other 2 targets are double WDs, whose small separations and faintness likewise make them difficult to measure using ground-based techniques. Observations have been completed for a 3rd double WD.

The bright stars, to be imaged with WFC3, are: (1) Procyon (P = 40.83 yr), containing a bright F star and a much fainter WD companion. With the continued monitoring proposed here, we will obtain masses to an accuracy of better than 1%, providing a testbed for theories of both Sun-like stars and WDs. (2) Sirius (P = 50.14 yr), an A-type star also having a faint WD companion, Sirius B, the nearest and brightest of all WDs. (3) Mu Cas (P = 21.08 yr), a nearby metal-deficient G dwarf for which accurate masses will lead to the stars' helium contents, with cosmological implications.

The faint double WDs, to be observed with FGS, are: (1) G 107-70 (P = 18.84 yr), and (2) WD 1818+126 (P = 12.19 yr). Our astrometry of these systems will add 4 accurate masses to the handful of WD masses that are directly known from dynamical measurements. The FGS measurements will also provide precise parallaxes for the systems, a necessary ingredient in the mass determinations.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13469
Program Title: Tol 26 and the EGB 6 Class of Planetary-Nebula Nuclei: What Happens to a Companion Star when a PN is Ejected?

Principal Investigator: Howard Bond

PI Institution: Space Telescope Science Institute

Tol 26 is a faint, compact, high-latitude planetary nebula (PN), little studied since its discovery in the 70's. Its nebular spectrum is unusual in having no [O II] or [N II], and strong [O III] 4363, indicating very high electron density. Tol 26 is unresolved from the ground. GALEX, BVRI, 2MASS, and WISE data reveal: a bright UV source, which we identify as the central star; optical flux consistent with a dK companion, and NIR and MIR excesses indicating the presence of warm

dust with two distinct temperatures.

Tol 26 resembles the formerly unique EGB 6, a faint PN with a compact nucleus, also containing a hot white dwarf (WD) and dual-temperature dust. EGB 6 has a close dM companion; HST imaging shows that the compact nebula coincides with the dM star, not the WD. We speculate that a portion of the outflow during PN ejection created an accretion disk around the dM star, which has survived to the present time, and is ionized by the WD's UV flux.

We propose WFC3 imaging of Tol 26, using filters that will separately isolate the hot central star, nebular emission, and the optical and NIR fluxes. We will determine whether there is likewise a resolved companion star in this system, and if so whether the nebular emission comes from an accreted disk around the companion, as in EGB 6. We will also obtain a FUV spectrum of Tol 26, to determine the Teff/log g of the central star and search for accreted metals. Our study will have wider implications for the spin-up of companion stars of PN nuclei, formation of barium stars, and the nature of 24-micron excesses discovered in several hot WDs and PN central stars. We will also obtain new images of EGB 6, last imaged by HST in 1995.

Proposal Category:	GO
Scientific Category:	Resolved Stellar Populations
ID:	13470
Program Title:	Probing Cold Dark Matter Substructure with Wide Binaries in Dwarf Spheroidal Galaxies
Principal Investigator:	Julio Chaname
PI Institution:	Pontificia Universidad Catolica de Chile

The mass function of dark matter (DM) halos is a central piece in the current framework of hierarchical structure formation. Although a wealth of information is available on the properties of DM halos with M>1e8 solar masses (Msun), lower-mass halos remain virtually inaccessible. In particular, we do not know whether there is substructure on scales below dwarf spheroidal (dSph) galaxies, nor whether the DM power spectrum cuts off at some low-mass value. Here we propose an experiment that, using resolved binary systems as gravitational test particles, will probe these unexplored regimes for the first time. We will measure the stellar 2-point correlation function in 370 square arcmin of the Ursa Minor dSph down to separations of 40 mas, corresponding to 3000 AU. If there is no DM substructure on small scales, we will detect a 6-sigma excess due to "wide" binaries at the smallest separations. On the other hand, if DM substructure exists on scales of 1e4 Msun at even 10% of the level predicted by standard theory, then these binaries will have been destroyed and there will be no excess at small separations. Because the wide-binary separation function is identical in the Milky Way disk and halo (despite being radically different dynamical environments), it is almost certain that dSphs were originally endowed with the same wide-binary distribution. Moreover, the interpretation of the resulting data is free from ambiguities, as there are no known mechanisms for destroying these binaries within dSph environments, other than DM subhalos. Thus this is, to the best of our knowledge, the only current experiment that could detect or rule out DM clustering on M=1e4 Msun scales.

Proposal Category:	GO
Scientific Category:	ISM in External Galaxies
ID:	13471
Program Title:	STIS Spectra of the Young SN Ia Remnant SN 1885 in M31
Principal Investigator:	Robert Fesen

PI Institution: Dartmouth College

The bright nova S Andromedae observed in August of 1885 in the central bulge of M31 had an optical spectrum lacking hydrogen lines defining it as Type I SN. Despite numerous optical, radio, and X-ray searches, the remnant of SN 1885 remained undetected across all wavelengths for over a century. It was only finally detected, by us, through ground-based near-UV images which revealed a 0.8" diameter dark spot of Ca and Fe resonance line absorptions visible through its silhouette against M31's bulge light.

The entire 128 year old remnant -- from its core to its outer edge -- can be studied through its strong resonance line absorptions due to its location on the near-side of M31's central bulge. In Cycles 17 and 19, we successfully imaged the remnant's absorptions in Ca I 4227, Ca II 3934,3968, Fe I 3720, and Fe II 2382,2599 lines. These images show a multi-armed distribution of Fe II absorption peaked in strength at the center of the remnant. They provide our first 2D views of the inner structure of any SN Ia event, reveal large-scale clumps and asymmetries in the remnant's Fe-rich ejecta, and may constitute the first direct observation of Rayleigh-Taylor plumes predicted by hydrodynamical simulations.

We propose obtaining STIS NUV and optical spectra of SN 1885's resonance line absorptions to give us deeper insights into the distribution of its metal-rich ejecta, especially the Fe-rich ejecta. SNR 1885's UV spectrum is predicted to be enormously rich. It offers an unique and powerful means to study the spatial and velocity structure of metal-rich ejecta in a Type Ia SN remnant through HST's UV and high-resolution capabilities.

Proposal Category: SNAP

Scientific Category: Cosmology

ID: 13472

Program Title: The Hubble Constant to 1%? STAGE 4: Calibrating the RR Lyrae PL relation at H-Band using HST and Gaia Parallax Stars

Principal Investigator: Wendy Freedman

PI Institution: Carnegie Institution of Washington

RR Lyrae stars have an IR PL relation with a precision of 1.5% in distance, which far exceeds the precision of the Cepheid PL relation. We are proposing here to set the zero point for a new and totally independent determination of the extragalactic distance scale, and the Hubble constant, at the <3% level. This is based on RR Lyrae variables tying out to Type Ia supernovae in the far-field Hubble flow using the Tip of the Red Giant Branch method. We will calibrate the RR Lyrae PL relation on the F160W (H-band) system of WFC3, totally eliminating systematic uncertainties in tying into any ground-based system. Currently there are 4 RR Lyrae stars with parallaxes determined by Benedict et al. (2011) using HST; hundreds more will be observed with Gaia. We are building a completely independent (Population II) path to the extragalactic distance scale and the Hubble constant using RR Lyrae variables at the base. This proposal is for snapshot observations of Gaia's 45 nearest (and brightest) Milky Way RR Lyrae variables. They will undoubtedly become "The Zero-Point Calibrators" for the entire Population~II distance scale for decades to come. They need to be observed now, and with HST. We are requesting 2 randomly-phased F160W WFC3 snapshot observations of our fiducial sample of 45 Milky Way calibrating field RR Lyrae. Template fitting to contemporary Spitzer light curves for these same stars will bring the uncertainties on their time-averaged mean magnitudes down to better than 0.02 mag which is designed to match the 1% error in parallax distances that Gaia will deliver for this select set of RR Lyrae calibration stars.

Proposal Category: GO

Scientific Category: ISM in External Galaxies

ID: 13473

Program Title: On the Nature of Highly Ionized Gas in the Halos of Normal Star-Forming Galaxies

Principal Investigator: Timothy Heckman

PI Institution: The Johns Hopkins University

One of the major discoveries made with the Cosmic Origins Spectrograph is that the halos of typical star-forming galaxies at low-redshift contain a major baryonic component in the form of highly ionized gas traced by the OVI ion. This discovery raises many important questions. Where did the gas come from, where is it going, and how is it energized? Is it photoionized by the meta-galactic background or is it hot collisionally-ionized gas? Is it gas in hydrostatic equilibrium at the virial temperature? Is it accreted material that is heated mechanically as it flows into the halo from the cosmic web? Is it outflowing material that is heated by feedback supplied by the massive stars in the galaxy? An important first step in answering these questions would be to precisely measure the ionization state of the gas traced by OVI. In this proposal we request 25 orbits using COS to do this by measuring the relative column densities of the NeVIII, OVI, and OIV ions in the halos of five typical star-forming galaxies at z = 0.5 to 0.6. These data will allow us to discriminate between photo- and collisional ionization, to determine whether the gas has a temperature close to the halo virial temperature, and to assess the amount of energy input required to sustain the hot halo. Unlike the three galaxies studied to date using these ions, ours will be the first 'fair sample' of typical L* star-forming galaxies. As such, these data will provide a unique new benchmark against which the increasingly sophisticated numerical simulations of galactic halos can be compared.

Proposal Category: GO

Scientific Category: Solar System

ID: 13474

Program Title: Imaging Polarimetry of the 2013 Comet ISON with ACS: A Study of the Heterogeneous Coma

Principal Investigator: Dean Hines

PI Institution: Space Telescope Science Institute

The great comet of 2013, currently referred to as Comet C/2012 S1 (ISON), is anticipated to be a unique observational opportunity. Comet ISON is a sungrazer on a nearly parabolic trajectory, similar to that of the Great Comet of 1680, and likely carries pristine material dating to the time of the solar-system formation. Recent polarimetric observations of other comets have found that different regions of the coma produce different polarimetric light-scattering responses, indicating that different portions of the coma contain different materials. The presence of a strongly negatively polarizing circumnucleus halo region that has been observed very near the nucleus of several comets suggest a depletion of absorbing, carbonaceous particles in this region. High spatial-resolution ACS polarimetric images of Comet ISON not only can be used to place bounds on the material constituents of different regions of its coma, but can also be used to explore its dynamics and acquire an understanding of the radiation-coma interaction that accounts for coma heterogeneities.

Proposal Category: GO
Scientific Category: Solar System
ID: 13475
Program Title: Hubble Imaging of a Newly Discovered Main Belt Comet

Principal Investigator: David Jewitt

PI Institution: University of California - Los Angeles

Main-belt comets (MBCs, or ``active asteroids'') have the orbital characteristics of asteroids but also show transient, comet-like activity. Examples of mass-loss likely caused by ice sublimation and by impact 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 the next MBC discovered in order to help determine the process driving mass-loss.

Proposal Category: GO
Scientific Category: Resolved Stellar Populations
ID: 13476
Program Title: Proper Motion and Internal Kinematics of the SMC: are the Magellanic Clouds bound to one another?

Principal Investigator: Nitya Kallivayalil

PI Institution: Yale University

We propose a long-term GO program of WFC3/UVIS imaging of 30 newly identified QSOs behind the Small Magellanic Cloud (SMC) to measure proper motions (PMs). A campaign separated by two years will allow us to measure the rotation, internal structure, and center-of-mass motion of the SMC. Our current understanding of these issues is limited by the small number of QSOs that were available to probe the SMC's motion (only 5). We now have a large number of well-distributed QSO fields that will enable a direct separation of the internal motions and the center-of-mass motion. We show that our SMC measurements will constrain all major outstanding questions about the dynamics and origin of the Magellanic system, within the precision of a two-year baseline program: whether the LMC and SMC are in a binary, whether they are on their first infall into the Milky Way, the implied Milky Way mass, and the rotation of the SMC. The latter will constrain whether the SMC is an example of a dwarf in transition between a gas rich, rotation-supported dwarf Irregular, and a dispersion-supported dwarf Spheroidal, and whether the LMC is responsible for this transition.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13477
Program Title: Unmasking the Supernova Impostors

Principal Investigator: C. Kochanek
PI Institution: The Ohio State University

We propose measuring the optical/near-IR/mid-IR spectral energy distributions of the three nearby "supernova impostors" SN1954J, SN1961V and SN1997bs. All three have have candidate surviving stars which, in order to explain their faintness, are believed to be shrouded by dusty shells formed during the eruption. If this hypothesis is correct, we will be able to estimate the mass lost in the eruption, a key step towards understanding the physics of eruptions and their role in the evolution of massive stars. In the case of SN~1961V, however, the most likely outcome is to conclusively show that the standard hypothesis is wrong and that the transient was a true supernova. This outcome is less likely for the other two targets, but it would be revolutionary and is not disallowed by the existing fragmentary data.

Proposal Category: GO
Scientific Category: Solar System
ID: 13478
Program Title: Hubble Imaging of the Nucleus of Comet ISON

Principal Investigator: Philippe Lamy
PI Institution: Laboratoire d'Astrophysique de Marseille

Comet C/2012~S1 (ISON) is both a new "nearly isotropic" and a sungrazing comet with an outstanding apparition in cycle 21, passing within 0.42 AU of the Earth.
We propose a 12-orbit Hubble postperihelion investigation of this comet that will provide a detailed view of its nucleus originating from the Oort cloud and of the possible consequences of its very close approach to the Sun at a perihelion distance of 0.012471 AU such as fragmentation.
We will determine the size, shape, rotational period, and color (UBVRI) of the nucleus of C/2012~S1 or of its fragment should disruption occurs.
This passage of a new "nearly isotropic" comet very close to

the Earth offers a rare opportunity to investigate this population of objects, and we expect many other observatories to attempt detecting its nucleus in the mid-infrared, millimetric and centimetric domains. Combining the Hubble results with those from other observatories should yield a comprehensive picture of this NIC that can be compared to the detailed data collected on ecliptic comets (ECs) during the past 3 decades. The differences and similarities between NICs and ECs should yield valuable insights into the origin and evolution of comets.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13479
Program Title: The host and location of the candidate relativistic tidal disruption event Swift 2058 +0516

Principal Investigator: Andrew Levan
PI Institution: The University of Warwick

Recent panchromatic observations have revealed a new class of high energy transient. These systems persist as bright gamma-ray sources for days, with luminosities in excess of the Eddington limit for a 10^10 solar mass black hole. They are accompanied by bright, long-lived (months to years) X-ray emission, and rather fainter, but still clearly detectable optical and IR counterparts. They are suggested to arise from the tidal disruption of stars in the nuclei of their host galaxies, which create a powerful relativistic outflow. In the first case (Swift J1644+57) astrometry ties the transient to nucleus of its host galaxy, lending support to this picture. However, other models have been postulated, such as the collapse of a giant star, where the outer envelope forms a disc that powers the observed transients, akin to a scaled-up gamma-ray burst. A key distinguishing feature between the two progenitors is their expected locations. Tidal disruptions must be uniquely nuclear, while GRB-like events are consistent with the nuclei of their hosts only 1/6 of the time. Here we propose to obtain deep observations of the second of these events -- Swift J2058+0516. These deep observations will detect and resolve its host galaxy, providing (via our earlier DDT observations) a precise location on the host. An IR visit will also provide a color for the host, and an estimate of its stellar and (through the bulge mass -- black hole mass relation) black hole mass. These data will provide the key astrometric and photometric evidence to disentagle competing models for these events, and will greatly aid the development of a definitive understanding of this new class of transient.

Proposal Category: GO
Scientific Category: Hot Stars
ID: 13480
Program Title: Super-luminous supernovae without host galaxies

Principal Investigator: Andrew Levan
PI Institution: The University of Warwick

Super-luminous supernovae (SLSNe) are a population of presumed core collapse events, whose peak luminosity is a factor up to a hundred greater than that of the majority of SNe (typically M_V < -22). Several models have been proposed for their progenitors, including an origin in the collapse of massive low metallicity stars in so called pair instability SNe, potentially making SLSNe a powerful link to the early Universe. In Cycle 20 we are undertaking a survey

of SLSNe hosts in the UV and IR. Remarkably, even at the deep limits of HST, 1/3 of these SLSNe have no detected host galaxy (F336W > 26.5, corresponding to absolute magnitude limits of M_UV ~ -13 at z~0.2), and another 1/3 lie on regions within their host where there is no sign of ongoing star formation. This may suggest either that these events arise in extremely low luminosity (and possibly low metallicity) star forming galaxies, or alternatively that we need to reasses their interpretation as core collapse events. Here we propose to resolve this discrepancy, by obtaining deep observations of 3 events without host galaxies in both the optical and IR. We will place limits that are a factor of ~6-8 deeper than those currently obtained, covering even the lowest luminosity star forming dwarf galaxies known, reaching limiting absolute magnitudes of M_V ~ -11. If we locate hosts in these images it would imply an origin in low metallicty star forming systems. Alternatively, their non-detection may suggest that they do not lie on host galaxies, and instead may be an older population, not formed through a conventional core-collapse mechanism, that has moved significantly from their birth sites before the supernova.

Proposal Category:	SNAP
Scientific Category:	ISM in External Galaxies
ID:	13481
Program Title:	Calibrating Multi-Wavelength Metallicity Diagnostics for Star-Forming Galaxies
Principal Investigator:	Emily Levesque
PI Institution:	University of Colorado at Boulder

We propose to obtain low-resolution COS-FUV spectra of a sample of nearby star-forming galaxies with existing rest-frame optical spectroscopy. By combining optical and UV observations of these galaxies, we will be able to directly compare previously-determined metallicities from optical emission line diagnostics with those determined from newly-observed photospheric and stellar wind lines in the UV, including the abundance-sensitive 1425A and 1978A photospheric blends. While each of these metallicity diagnostics has been individually examined and calibrated, there is currently no quantitative conversion relating diagnostics between the optical and UV regimes. These observations will offer the first empirical sample that can be used, in conjunction with stellar population synthesis and photoionization models, to develop a self-consistent multi-wavelength baseline for unifying metallicity measurements in star-forming galaxies spanning a broad range of redshifts. In addition, rest-frame UV galaxy spectra such as these will be exceptionally important in the coming decade as the Extremely Large Telescopes come online. At the higher redshifts made reachable from the ground by these facilities, the UV regime will become the "new" rest-frame for ground-based extragalactic astronomy, demanding a thorough understanding of UV spectra and diagnostics.

Proposal Category:	GO
Scientific Category:	Quasar Absorption Lines
ID:	13482
Program Title:	The Evolving Gas Content of Galaxy Halos: A Complete Census of MgII Absorption Line Host Galaxies at 0.7 < z < 2.5
Principal Investigator:	Britt Lundgren

PI Institution: University of Wisconsin - Madison

Background quasars provide a unique tool for probing the cold gas content of galaxy halos, independent of luminosity, from z~6. Intervening absorption from singly-ionized Magnesium (Mg II) is theoretically capable of tracing the stripping, accretion and outflows of cold, enriched gas - processes understood to be fundamental in regulating galaxy evolution. Despite the tens of thousands of Mg II absorbers now available from the SDSS spectroscopic quasar sample, their utility in aiding our understanding the evolution of galaxies has been limited due to the difficulty of detecting their luminous counterparts at high redshifts and on small angular separations from the background quasar.

To finally resolve this problem, we propose to harness the peerless sensitivity and resolving power of the WFC3/IR G141 grism in a 18 orbit program to obtain observations of galaxies around the 9 most absorber-rich quasar sight lines in the SDSS. These data will enable us to, for the first time, study the properties (morphologies, inclination angles, star formation rates, star formation rate surface densities) of a complete sample of 54 typical Mg II-selected galaxies at z>0.7. Most importantly, we will observe these absorber-selected galaxies at virtually unlimited impact parameters (5 to 450 kpc) and to extremely low star formation rates (1 Msun/yr), thus eliminating the most prohibitive biases of past observations.

Proposal Category: GO
Scientific Category: ISM in External Galaxies
ID: 13483
Program Title: eLARS - extending the Lyman Alpha Reference Sample

Principal Investigator: Goeran Oestlin

PI Institution: Stockholm University

Despite its pivotal importance in high-z astrophysics, Lyman alpha (LyA) imaging is a relatively unexplored territory, due to its reliance on HST for far UV imaging. Our team has pioneered systematic LyA imaging in the local universe and developed techniques for producing photometrically accurate images using HST. We recently finished LARS, the first systematic LyA imaging study of 14 UV+H-alpha selected starbursts in the local universe. We found further evidence for LyA variation on physical scales from 30 pc to several kpc, often in a manner uncorrelated with the UV continuum, H-alpha or the galaxy in general. Specifically, we find that when LyA is bright and when a lot of LyA manages to escape, it is always found in the form of a large scale halo. This is, in all such cases, more extended than the UV or H-alpha emission, but rarely symmetric.

While these results are fascinating, LARS consists of extreme starbursts that contribute only a small fraction of the total UV and star-formation density at low and intermediate (z~2) redshifts. Given the importance of the LyA line for finding galaxies and for galaxy evolution studies it is imperative to now generalize the investigation and produce a fully representative quantitative framework. We here propose to image a sample of 28 local galaxies, dominated by more disk like objects (c.f. the irregular objects of LARS), and the kind of objects than dominate the local FUV luminosity function. Specifically, we will investigate the effects of geometry and galaxy orientation of the emergent LyA emission.

Proposal Category: GO
Scientific Category: Resolved Star Formation
ID: 13484

Program Title: Structure, Excitation, and Evolution of Shocks: A Multi- Wavelength Study of Herbig-Haro 1/2

Principal Investigator: Bo Reipurth

PI Institution: University of Hawaii

More than 1000 Herbig-Haro (HH) objects are known today. Among these, HH 1 and HH 2 are taking a special place because they remain the brightest known HH objects in the sky. As such, they have been studied at all wavelengths, from X-rays to the radio continuum, and with all observing techniques. Adding to this their fine bipolar morphology displaying two major bow shocks and a finely collimated jet, it is no surprise that HH 1 and 2 constitute the reference frame against which data on all other HH objects are compared. We propose to observe HH 1/2 with the following narrowband filters (in order of wavelength) offered by WFC3: [Ne IV] 2425, Mg II 2795+2802, [O II] 3726+28, H-beta 4861, [O III] 5007, [O I] 6300, H-alpha 6563, [S II] 6717, and [S II] 6731. These lines probe different shock velocities and physical parameters, hence the analysis of the resulting images allow us to explore a number of scientific questions related to the physical conditions in the shocks, their structure and their kinematics. We have at our disposal the sophisticated adaptive grid code "yguazu" in which the gasdynamic equations are integrated together with a many-species ionization network. This allows us to compute both 2D and full 3D models of HH flows from which we can directly obtain predictions of emission maps in all of the above transitions, aiding the interpretation of the line ratio maps. The resulting study will provide a major step forward in our understanding of the shock physics of outflows from young stars.

Proposal Category: GO

Scientific Category: Resolved Star Formation

ID: 13485

Program Title: The HH 24 Jet Complex: Collimated and Colliding Jets from a Newborn Multiple Stellar System

Principal Investigator: Bo Reipurth

PI Institution: University of Hawaii

The HH 24 complex constitutes the richest concentration of collimated bright Herbig-Haro jets known, and they originate from a small grouping of newborn binary and multiple systems. At least 6 jets are identified in deep groundbased optical interference images, and a similar number of sources in infrared images. We propose to do the first HST study of this complex, using H-alpha and [SII] filters. HST 0.05" to 0.1" angular resolution (20 to 40 AU at d~400 pc) is needed to resolve the shocks and their post-shock cooling layers for comparison with advanced numerical modeling. Our emphasis here is to explore outflows from a multiple system of newborn stars. Many of the jets show clear evidence of wiggling. The theory of jet motion from binary systems coupled with disk precession is now understood, and we will interpret the jet wiggles in this framework. Additionally, two of the HH 24 jets are showing evidence for a collision, a unique situation not seen anywhere else, and HST resolution is needed for comparison with gas-dynamic studies of jet-jet collisions. Two of the HH 24 jets are bright in the infrared [FeII] 1.644 line. In this line the main jet can be traced all the way to the source, which is the most important region for understanding the effects of binarity on the jet structure. We also apply for a second-epoch [SII] image in Cycle 23. This allows us, in addition to deriving the bulk motion, to determine such processes as expansion of the jet beam, sideways ejection in a working surface, turbulent and chaotic motions, and the effect of instabilities.

Proposal Category: GO
Scientific Category: ISM and Circumstellar Matter
ID: 13486
Program Title: Spectral Time Series of the Cas A Supernova

Principal Investigator: Armin Rest

PI Institution: Space Telescope Science Institute

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

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

Proposal Category: SNAP
Scientific Category: Extra Solar Planets
ID: 13487
Program Title: A pilot study to characterize the Lyman alpha emission of active exoplanet host stars

Principal Investigator: Michael Salz

PI Institution: Universitat Hamburg, Hamburger Sternwarte

We propose to measure the strength of the stellar hydrogen Lyman alpha emission in a sample of seven planet host-stars with transiting hot Jupiters using HST-STIS snapshots. Strong UV irradiation is thought to heat the outer planetary atmosphere leading to atmospheric expansion that may result in substantial mass-loss. Expanded hydrogen atmospheres have been detected around the two hot Jupiters HD 209458 b and HD 189733 b by means of Ly alpha transit spectroscopy, which is only possible with the HST. Further observational studies of planetary atmospheres are crucial to constrain model calculations and improve our understanding of planetary mass-loss. We compiled a sample of planet host-stars with the strongest anticipated Ly alpha fluxes. The accuracy of these estimates is fundamentally limited by uncertainties in the intrinsic stellar emission and the interstellar absorption column density. The proposed program is needed to establish the true Ly alpha fluxes and identify suitable targets for follow-up transit campaigns aimed at detecting the planetary atmosphere.

Proposal Category: GO
Scientific Category: Solar System
ID: 13488
Program Title: Using Hubble to Resolve Fundamental Discrepancies in the Surface Composition of the Asteroid (21) Lutetia

Principal Investigator: Andrew Steffl
PI Institution: Southwest Research Institute

(21) Lutetia is one of the largest asteroids in the main belt, with dimensions of 121x101x75 km along its principal axes of inertia. On July 10, 2010, the European Space Agency's Rosetta spacecraft passed within 3168 +/- 7.5 km of Lutetia's surface. However, even after the Rosetta flyby, fundamental uncertainties remain about the composition of Lutetia's surface. The primary reason for this is that from visible to millimeter wavelengths, Lutetia's reflectance spectrum is almost completely devoid of absorption features and contains nothing that can uniquely constrain its surface composition. The scientific literature is now split with about half advocating an enstatite chondrite composition and half a carbonaceous chondrite composition. Although these materials look similar in the visible/IR, they have markedly different appearances in the NUV. In addition, the FUV spectrograph on the Rosetta spacecraft identified a strong absorption edge in Lutetia's spectrum at 170nm. This could be indicative of plagioclase feldspar minerals or water ice. The presence of either of these materials is not expected on Lutetia's surface and would be a major discovery. However, it is not possible to confirm/rule out their presence using existing data--for that NUV spectra are required. We propose a focused, 4-orbit program to obtain the spectrum of Lutetia from 180-570nm using STIS/G230L and STIS/G430L.

Proposal Category: GO
Scientific Category: AGN QUASARS
ID: 13489
Program Title: Accretion Physics in Nearby FR1 Galaxies

Principal Investigator: John Stocke
PI Institution: University of Colorado at Boulder

We propose to obtain COS G130M spectra of three of the nearest FR1 radio galaxies including M87 in order to measure Lyman alpha emission line and ionizing continuum luminosities to test accretion models. The accretion process in FR1s is poorly understood. The absence of a luminous accretion disk in these "radio mode" AGN has led to various "radiatively inefficient accretion flow" (RIAF) models, but whose basic parameters remain poorly quantified. While our serendipitous discovery of weak 10^40 ergs/s Lya emission in a few BLLac Objects strongly suggests that RIAFs must contain some cool material close to the black hole, our result was partly compromised by beaming; i.e., while the Lya emission line is unbeamed, the BLLac continuum is beamed. To overcome this shortcoming we propose to obtain COS FUV spectroscopy of representative FR1s to determine their Lya emission line luminosity, FWHM and line shape as well as their unbeamed ionizing continuum luminosity. These measurements will allow us to estimate the location,

kinematics and amount of cool mass in the FR1 broad-line region. These observables will be used to test variants on the general RIAF scheme including models with "external accretion disks" and out-flowing winds and models with magnetically regulated accretion flows. By using Lya emission we can probe regions very close to the nucleus, a factor of at least ten closer than the regions probed by diffuse X-ray emission. This will allow us to assess whether the very efficient accretion suggested by the X-ray analysis is plausible or whether a more sophisticated accretion model must be developed to understand these AGN and their powerful jets.

Proposal Category:	GO
Scientific Category:	Unresolved Stellar Populations
ID:	13490
Program Title:	Resolving the Reddest Extragalactic Sources Discovered by Spitzer: Strange Dust-Enshrouded Objects at z~2-3?
Principal Investigator:	Jason Surace
PI Institution:	California Institute of Technology

We request 14 orbits with WFC3/IR to spatially resolve a sample of extraordinary objects that are ultraluminous in the mid-infrared (24 microns), but were undetected at all other Spitzer, optical, or near-infrared survey wavelengths. Found in the widest of the extragalactic areal surveys (SWIRE; 50 square degrees) these are the only such objects found by Spitzer. Followup infrared spectroscopy centered on the 24-micron band of three objects indicates that they lie between redshifts of 2-3. Additional ultradeep imaging of the entire sample with Spitzer and Keck has added photometric datapoints at 2.2 and 3.6 microns. Combined with the photometric upper limits, the resulting spectral energy distributions (SEDs) are not compatible with that of any known class of objects, although several lines of evidence point towards unusual, highly-obscured AGN, possibly undergoing fueling before the host galaxy has been fully established. The deep Keck imaging cannot achieve sufficient S/N to resolve the objects, but at least demonstrates that they can be observed with HST.

Due to their unusual SEDs, in most cases the sum total of our knowledge about these objects amounts to three photometric datapoints and some upper limits. The WFC3 imaging will add our only information about their structure, size, and shape. This in turn will allow us to differentiate between several proposed models shaping the SED.

Proposal Category:	GO
Scientific Category:	Quasar Absorption Lines
ID:	13491
Program Title:	Directly Probing >10^6 K Gas in Lyman Limit Absorbers at z > 2
Principal Investigator:	Todd Tripp
PI Institution:	University of Massachusetts - Amherst

The ultraviolet spectrum of the QSO HS1700+6416 (z_qso = 2.736) is remarkable - this spectrum reveals "partial" Lyman limit absorption at six different redshifts ranging from z = 1.1573 to 2.4331. Despite these absorption systems, the QSO is relatively bright in the HST band and provides a unique opportunity to study extreme ultraviolet absorption lines at rest wavelengths < 500 A. We propose to obtain high S/N, high-resolution COS spectroscopy of

this QSO to characterize the hot gas in the circumgalactic media traced by the six Lyman limit absorbers as well as other systems along the line of sight. We will search for 15 ions that trace gas at log T > 6 (e.g., MgIX, SiXII, SXIV, FeXVI, and others) to gain insight on the missing baryons, the "hidden" mass of hot gas in galactic outflows and halos, and the relationships between the hot and cool gas phases in circumgalactic gaseous media. In addition to the Lyman limit systems, the sight line also pierces the intracluster media of two lower redshift X-ray bright clusters at an impact parameter near the cluster virial radii, as well as a high-redshift protocluster at z = 2.3. ACS and WFC3 imaging and IR grism spectroscopy of galaxies near the sight line have already been obtained, and a large sample of galaxy redshifts have been measured for objects at z > 2. Consequently, the proposed COS spectrum will have many archival uses beyond our primary science goals.

Proposal Category:	GO
Scientific Category:	Solar System
ID:	13492
Program Title:	Hubble Spectroscopy of Sungrazing Comet ISON
Principal Investigator:	Harold Weaver
PI Institution:	The Johns Hopkins University Applied Physics Laboratory

The recent discovery of Comet ISON (C/2012 S1) at a heliocentric distance of ~6 AU, and its identification as a dynamically new comet passing within two solar radii of the Sun in November 2013, present an exceptional opportunity to investigate the heliocentric evolution of a comet's volatile composition and how that composition responds to an intensive heating event.
C/ISON is predicted to be very bright this fall (naked eye visibility), with large gas production rates enabling higher than usual sensitivities to be achieved. We propose a series of HST observations of C/ISON that aim to:
(1) monitor the evolution of CO production with heliocentric distance,
(2) search for compositional changes associated with the intense heating episode during the comet's close approach to the Sun,
and (3) measure D/H in this comet.
Our focus here is on scientific objectives that are uniquely accomplished via ultraviolet observations with Hubble.
