Cycle 19 Abstract catalog (based on Phase I submissions)
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12462
Title: The Remarkable Young Supernova Remnant in NGC 4449
PI: Knox Long
PI Institution: Space Telescope Science Institute

In the irregular galaxy NGC 4449 lies a young core-collapse supernova remnant (SNR) with remarkable optical, radio, and X-ray luminosities. With an estimated age of just 50 - 100 years, it fills an important gap in our understanding of the evolutionary development of a SNR as its forward shock and stellar debris expand into the local circumstellar environment. This is a proposal to use STIS to obtain new UV spectra of this extraordinary object, an extreme example of objects that are now making the transition from free expansion to a shock-dominated phase. Optical spectra and X-ray observations show that emission from the SNR has changed since it was observed with the FOS in 1993. We will use STIS spectra together with existing ground-based observations to (1) explore the abundances and kinematic distribution of elements in the ejecta from this core-collapse SN and compare these with nucleosynthesis models; (2) probe the interaction of the SN blast wave with what must be a very dense environment to produce its extraordinary luminosity; and (3) assess the surrounding stellar population that gave rise to this SNR. UV observations with HST are critical to a better understanding of the SNR, since this is the only way to gain access to carbon and hence measure CNO abundance ratios needed to estimate the precursor mass, and the only way to characterize shocked gas with temperatures of order 100,000 - 300,000 K. The combination of UV sensitivity and narrow slit to better isolate the SNR and stellar components makes STIS ideally suited to the needs of this program.
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Proposal Category: GO
Scientific Category: SOLAR SYSTEM
ID: 12463
Title: Target of Opportunity Imaging of an Unusual Cloud Feature on Uranus
PI: Heidi Hammel
PI Institution: Space Science Institute

The planet Uranus demonstrated increased atmospheric activity around the time of the 2007 equinox, likely in response to extreme insolation change (Sromovsky et al. 2009, Icarus 203, 265). Convective sites in the planet's southern hemisphere reached unprecedented altitudes in 2003 (Hammel et al. 2005, Icarus 175, 284); a bright northern feature showed the highest contrast yet detected in an outer planet atmosphere (Sromovsky et al. 2007, Icarus 192, 558); and a dark atmospheric feature was detected by Hubble (Hammel et al. 2009, Icarus 201, 257). The historical record makes references to discrete structures (both bright and dark) on Uranus during previous equinoctial apparitions (the last equinox occurred in 1965). The best amateur facilities are now just able to resolve the disk of Uranus and detect such activity if it is very large or has very high contrast. Amateurs also have access to a great many nights of telescope time. If a discrete cloud feature on Uranus is reported through the amateur network, we propose to obtain follow-up images with Hubble's WFC3. The proposed TOO images will permit determination of detailed structure of the feature at visible wavelengths, and will provide

vertical and horizontal constraints on the feature's scattering properties. Hubble is the only facility that can provide such information at visible wavelengths. The proposal was accepted in earlier cycles, but not executed because the defined criteria for activation were not met. Because the timescales of change on Uranus are unknown, we resubmit this for consideration in the current cycle.
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Proposal Category: GO
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12464
Title: Project MUSCLES: Measuring the Ultraviolet Spectral Characteristics in Low-mass Exoplanetary Systems
PI: Kevin France
PI Institution: University of Colorado at Boulder

Extrasolar planets orbiting M-stars may represent our best chance to discover habitable worlds in the coming decade. The ultraviolet (UV) spectrum incident upon the habitable zone of these planets drives the dissociation of water, the production of ozone, and may determine their ultimate habitability. Despite the importance of the incident UV radiation for understanding planetary atmospheres in the habitable zone, existing model calculations have not used measured, local UV fluxes. At present, we lack the observational and theoretical basis to predict the far- and near-UV spectrum of an M-dwarf. We propose Project MUSCLES (Measuring the Ultraviolet Spectral Characteristics in Low-mass Exoplanetary Systems) to remedy this situation by building the first spectrally and temporally resolved catalog of local M-stars hosting exoplanetary systems.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12465
Title: A Massive Star Census of the Starburst Cluster R136
PI: Paul Crowther
PI Institution: University of Sheffield

We propose to carry out a comprehensive census of the most massive stars in the central parsec (4") of the starburst cluster, R136, which powers the Tarantula Nebula in the LMC. R136 is both sufficiently massive that the upper mass function is richly populated and young enough that its most massive stars have yet to explode as supernovae. The identification of very massive stars in R136, up to 300 solar masses, raises general questions of star formation, binarity and feedback in young massive clusters. The proposed STIS spectral survey of ~36 stars more massive than ~50 solar masses within R136 is ground-breaking, of legacy value, and is specifically tailored to a) yield physical properties; b) detect the majority of binaries by splitting observations between Cycles 19 and 20; c) measure rotational velocities, relevant for predictions of rotational mixing; d) quantify mass-loss properties for very massive stars; e) determine surface compositions; f) measure radial velocities, relevant for runaway stars and cluster dynamics; g) quantify radiative and mechanical feedback. This census will enable the mass function of very massive stars to be measured for the first time, as a result of incomplete and inadequate spectroscopy to date. It will also perfectly complement our Tarantula Survey, a ground-based VLT Large Programme, by including the most massive stars that are inaccessible to ground-based visual spectroscopy due to severe crowding. These surveys, together with existing

integrated UV and optical studies will enable 30 Doradus to serve as a bona-fide template for unresolved extragalactic starburst regions.
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Proposal Category: GO
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12466
Title: The State of High Ionization Gas in 11 Intermediate Redshift Galaxies and Their Surroundings
PI: Jane Charlton
PI Institution: The Pennsylvania State University

Understanding the properties of the gas that lies in the environments of galaxies is essential for understanding their formation and evolution. This gas may include a variety of structures, such as infalling high-velocity clouds, tidal debris, material ejected in galactic winds, and gas stripped from dwarf galaxies. Near the Milky Way, OVI associated with HI high-velocity clouds (HVCs) has provided strong evidence for the presence of an extended and hot (~ 1 million K) corona. At high redshifts, strong and weak MgII absorbers have been hypothesized to serve as a proxy for detecting these high velocity clouds. Characterizing the properties of the OVI absorption associated with these MgII absorbers is therefore a highly effective tool to push the study of the galactic environment to higher redshifts. High resolution absorption line spectra, which allow us to determine velocities, metallicity, and ionization conditions, will allow us to carry out such study. Previously, we used Cycle 9 STIS E230M near-UV spectra to locate and analyze the CIV associated with 11 MgII absorbers (both strong and weak) in galaxies at 0.4< z<1.0, and we conducted extensive photoionization modeling on these systems. Although model parameters were clear for the low ionization gas, there are ambiguities in the case of the high ionization phase. Here we propose to use the Cosmic Origins Spectrograph (COS) in the far-UV to obtain spectra covering OVI and other needed diagnostics (Lyman series, CIII), with sufficient S/N to discriminate between photoionization and collisional ionization for these systems. The high efficiency of COS will allow us to carry out these observations in 11 orbits.
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12467
Title: Probing ISM in the Stellar Disk of Dwarf Galaxy GQ1042+0747
PI: Sanchayeeta Borthakur
PI Institution: The Johns Hopkins University

QSO-galaxy pairs with small impact parameters of few kpcs are very rare. The QSO-galaxy pair J104257.5+074850.5-GQ1042, presents a unique opportunity to study the the stellar disk of an extragalactic source at an impact parameter of 1.7 kpc. In addition, the background QSO is bright in the UV as well as radio frequencies, thus allowing us to probe the cold (21 cm HI) gas as well as warmer components enveloping it. Taking advantage of the radio brightness of the quasar, we have obtained high spectral (0.3 km/s) and spatial (parsec-scale) resolution data and detected a very narrow (3.6 km/s) absorber of expected column density of ~1x10^20 cm^{-2}. We found significant variations in the optical depth within the cloud (cloud of size ~14x27 pc). We request HST time to observe this QSO-galaxy pair with COS. We aim to probe the warmer phases of gas associated with the cold 21 cm absorber and hope to study the multi-phase ISM cloud structure in this dwarf spiral galaxy in detail. This

system is one of the few galaxies outside our local group where we can study the ISM within the stellar disk at such small scales. This makes it an excellent test bed for ISM theories in dwarf galaxies and for studying how ISMs of smaller galaxies differ from those of bigger galaxies such as the Milky Way.
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Proposal Category: SNAP
Scientific Category: SOLAR SYSTEM
ID: 12468
Title: How Fast Did Neptune Migrate? A Search for Cold Red Resonant Binaries
PI: Keith Noll
PI Institution: Space Telescope Science Institute

"Cold Classical" transneptunian objects share a unique set of physical properties that were acquired in their nascent environment in the protoplanetary disk. These objects are red, have high albedos, and a high fraction (>30%) are binaries with nearly equal mass components. They appear to be a relatively undisturbed remnant of the original protoplanetary disk and are concentrated in non-resonant, low inclination orbits between the 3:2 and 2:1 resonances at 39.4 and 47.7 AU. As Neptune migrated outwards in the first several hundred million years of the solar system, its mean-motion resonances moved through and were able to capture some of these objects. Identifying Cold Classicals trapped in resonances will allow us to discriminate between the two leading models for Neptune's migration. Smooth migration will result in measurable differences between resonances, fast migration (including transport by planetary scattering) will not. To accomplish this we are proposing to survey all Resonant transneptunian objects that have not yet been observed with HST to search for the distinctive physical markers of captured Cold Classicals. We will significantly increase the number of objects observed for binary companions and the number with measured colors. The database of observations derived from this survey will provide significant added value to the HST archive.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12469
Title: High-Precision Proper Motion Measurements of the Stars in the Field of SN 1572 with WFC3/UVIS
PI: Pilar Ruiz-Lapuente
PI Institution: Universidad de Barcelona

We propose to refine the space-velocity measurements of the stars in the central region of SNR 1572, one of the historical Galactic Type Ia supernova remnants. A single-orbit visit with the WFC3/UVIS would allow, in combination with the previous ACS/WFC images obtained in 2003-2005, an astrometric precision of less than 0.05 mas, almost one order of magnitude better than our previous result. Precise knowledge of the kinematics of all of the stars in the region is crucial for determining which one might be the surviving binary companion of the supernova. A precise reconstruction of the parameters of the binary system that gave rise to the supernova would then be possible, complementing the existing observations both from the ground and with the HST, which span the last fourteen years.
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Proposal Category: GO
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12470
Title: Super-Group 1120-1202: A Unique Laboratory for Tracing Galaxy Evolution in an Assembling Cluster at z=0.37
PI: Kim-Vy Tran
PI Institution: Texas A & M Research Foundation

We propose to obtain WFC3 F390W imaging of the super-group 1120-1202 that, combined with our existing ACS F814W mosaic, will provide the first high resolution color maps of >150 confirmed group galaxies at z~0.37. SG1120 is composed of 4 distinct groups collapsing into a Coma-like cluster, thus SG1120 is a unique laboratory for pinpointing where star formation in individual galaxies is triggered/quenched and identifying the driving physical mechanism. SG1120 members include major mergers, infalling galaxies, >50 IR-bright members, multiple Active Galactic Nuclei (AGN), and ~30 star-forming members with broad optical line-widths corresponding to velocities of 200-2000 km/s. SG1120's diverse population makes it particularly well-suited for tracing the interplay between environment, star formation, AGN, gas outflows, and morphological evolution. Only WFC3 F390W provides the blue wavelength coverage and high spatial resolution needed to (1) resolve compact star-forming regions; (2) separate colors of the bulge/disk components; and (3) measure color gradients, and so test for differences in stellar age due to a variety of models proposed to drive galaxy transformation.

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Proposal Category: GO
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12471
Title: The Bottom of the Iceberg: Faint z~2 Galaxies and the Enrichment of the IGM
PI: Dawn Erb
PI Institution: University of Wisconsin - Milwaukee

Galaxies at z~2-3 formed stars rapidly and expelled large quantities of gas to great distances via powerful galactic outflows. Much has been learned about interactions between star-forming galaxies and the IGM from our joint galaxy/QSO survey in which high quality spectra of bright QSOs are used to sample the gas around foreground galaxies. With this proposal we extend that survey to large numbers of significantly fainter galaxies, via a spectroscopic WFC3/IR grism survey of 15 QSO fields and their surrounding foreground galaxies. This survey takes advantage of the grism's optimal sensitivity to high equivalent width emission lines from compact sources. It will encompass ~1500 galaxies at $1.5<z<2.3$, 1000 of which are fainter than the current survey limit and 2/3 of which do not appear in our photometric catalogs because of incompleteness. In only 30 orbits (and in a single step, rather than through the construction of an HST-based photometric catalog followed by spectroscopy) this sample will increase the number of spectroscopically confirmed galaxies near QSO sightlines by up to a factor of ~6, and will allow a study of the impact of these numerous faint galaxies on the IGM. The grism data will also provide spatially resolved measurements of the sizes of the line emitting regions, for studies of the relationship between the star formation rate density and the strength of galactic outflows, for the first time at z~2. Thus the survey will address two outstanding problems in the study of galactic outflows at high redshift: the lack of dynamic range in mass, luminosity and metallicity in the sample, and the lack of spatially resolved measurements of line emission.

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Proposal Category: GO
Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12472
Title: CCC - The Cosmic Carbon Conundrum
PI: Claus Leitherer
PI Institution: Space Telescope Science Institute

We propose STIS G230L ultraviolet spectroscopy of a carefully chosen sample of starburst galaxies to measure the strength of the C III] 1909 and other diagnostic lines. The C III] line is a key indicator of the carbon abundance. Atomic physics and ionization conditions in galaxies preclude any determination of nebular carbon abundances in the optical. Only HST's ultraviolet capabilities allow us to document, explore, model, and interpret the behavior of the 4th most abundant element in the universe in these galaxies. Our sample of 18 galaxies exhibits the signatures of Wolf-Rayet stars, whose presence will greatly facilitate population synthesis modeling and at the same time will provide clues on possible short-comings in stellar evolution modeling. The sample is large enough for meaningful statistics and parameter space coverage but still allows us to reach our science goals in an economic way. Together with short but deep co-spatial optical spectroscopy we will use the data for comparison with Mappings III photoionization models to determine abundances of the major elements. The full star-formation history will be established using the Starburst99 code. We will investigate the behavior of, e.g., C/O vs. O/H in order to constrain the production mechanism of carbon. We will test the predictions of chemical evolution models of galaxies and address the importance of starburst durations, infall, and outflows. The proposed study will help us understand the puzzling carbon abundances in objects as diverse as low-mass Galactic halo stars or distant damped Lyman-alpha absorbers.
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Proposal Category: GO
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12473
Title: An Optical Transmission Spectral Survey of hot-Jupiter Exoplanetary Atmospheres
PI: David Sing
PI Institution: University of Exeter

Using transits to obtain optical transmission spectra is a powerful technique to enable detailed studies of exoplanet atmospheres. Importantly, they are sensitive to the atmospheric composition at high altitudes where the bulk of the intense stellar flux is being deposited. Several outstanding issues in the field of exoplanets are related to the energy balance and heating sources in hot Jupiters, and can be directly addressed with optical transmission spectra. Thermal inversion layers have been detected on many hot-Jupiter atmospheres and require one or more strong optical absorbers at high altitude. These absorbers capture the incoming intense stellar radiation, heating the surrounding gas to produce a thermal inversion layer. The composition, variety, and universality of these strong absorbers remains uncertain and the topic of much debate within the community. While IR secondary eclipse information can help determine which planets have inversions, the absorbers themselves can only be directly detected through optical transmission spectra. Here we propose to use the unique capabilities of the refurbished HST STIS instrument to perform the first large-scale optical transmission spectral

survey of hot-Jupiter exoplanets, with the overall aim of comparing their atmospheric properties, detecting strong absorbers, and probing the diversities between possible sub-classes. The eight targets sampled in this survey cover a very large range of planetary Teff, surface gravity, mass and radii, which will for the first time explore the full diversity of hot-Jupiter atmospheres as well as identify important physical processes common to the entire class.
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Proposal Category: SNAP
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12474
Title: The frequency and chemical composition of rocky planetary debris around young white dwarfs
PI: Boris Gaensicke
PI Institution: The University of Warwick

Over the past few years, it has become increasingly clear that the most plausible scenario to explain the metal-pollution observed in ~20% of all cool white dwarfs is accretion from rocky planetary material - suggesting that these white dwarfs may have had, or may still have terrestial planets as well. This hypothesis is corroborated through the infrared detection of circumstellar dust around the most heavily polluted white dwarfs. Traditionally, the detection of metal pollution is done in the optical using the Ca K line, leading to a strong bias against warmer and younger white dwarfs. Hence, most of our knowledge about the late evolution of planetary systems is based on white dwarfs with cooling ages >0.5Gyr. Our ongoing Cycle 18 COS ultraviolet snapshot survey represents the first systematic and unbiased investigation of the fraction of planetary systems around young (20-200Myr) white dwarfs. The results obtained so far are very promising, three out of 21 observed white dwarfs are metal polluted, and demonstrate variations in the chemical abundances of the circumstellar debris. Our ultimate goal, correlating the presence of planetary debris with white dwarf (and hence progenitor) mass and cooling age, as well as determining the relative Si, C, and possibly N, O, and Ni abundances of the debris, requires COS observations of ~80-100 white dwarfs, roughly twice the number of snapshots expected to be executed by the end of Cycle 18. We therefore propose to continue this successful snapshot program into Cycle 19.
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Proposal Category: GO
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12475
Title: Cool Star Winds and the Evolution of Exoplanetary Atmospheres
PI: Seth Redfield
PI Institution: Wesleyan University

Stellar mass loss is a ubiquitous property of stars, and most stars may host planetary companions. While we are just in the initial stages of assessing how common exoplanets may be, there already exists a rich body of work that seeks to understand the profound connection between a star and its planets, particularly their atmospheres. The unique properties of a star's electromagnetic radiation and particle wind can dictate a planet's thermal and chemical atmospheric structure. Indeed, the solar wind likely eroded a warm and wet ancient Martian atmosphere. As our capability to discover and characterize exoplanets and their atmospheres continues to improve, the

habitability of these planets will become a central and potentially radical scientific research question. At the heart of this question will be the relationship of the planet with its host star. The detection of the relatively weak winds of cool, solar-like stars can only be made with high resolution UV spectra. The interaction of a stellar wind with its surrounding interstellar medium produces detectable HI Lyman-alpha absorption, where the amount of absorption is proportional to the mass loss rate. We propose observations of a sample of 4 nearby exoplanetary host stars in order to measure their winds and enable an evaluation, not only of the current stellar conditions, but to reconstruct its evolution over the course of its lifetime. These measurements by HST will provide exclusive insight into how stellar winds influence planetary atmospheres that the community will draw upon long after HST has ended its mission, as the detection and characterization of planets like our own is just beginning.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12476
Title: Measuring the Hubble Flow Hubble Constant
PI: Kem Cook
PI Institution: Lawrence Livermore National Laboratory

We propose to use the Wide Field Camera 3 to extend our Cycle 15 program to phase Cepheid variables in a spiral galaxy in the core of the Coma cluster. With an investment of just 34 orbits, we will obtain a Cepheid distance to Coma accurate to 5%. A direct application of the canonical primary distance indicator at 100 Mpc will measure the far-field Hubble constant free of many of the systematic uncertainties which beset current determinations relying on secondary indicators. Establishing the far-field Hubble constant with Cepheids will provide one of the strongest links in the extragalactic distance scale and will robustly calibrate the fiducial fundamental plane of elliptical galaxies and type Ia supernovae. From five epochs prior to ACS failure in Cycle 15, our WFC observations of NGC4921 in Coma produced at least 50 Cepheid candidates with S/N=5 to 10 or better and periods of 40d to 70d. Efficient phasing of these and discovery of additional Cepheids can be done with 12 epochs of observations with WFC3, optimally spaced for long-period Cepheids. The better spatial sampling of WFC3 will improve on our already robust detections and the F350LP filter allows a dramatic reduction in the required observing time. We will supplement these data with two additional F606W (wide-V) epochs to tie in with and leverage our Cycle 15 data to obtain accurate mean magnitudes in standard bandpasses.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12477
Title: Weak lensing masses of the highest redshift galaxy clusters from the South Pole Telescope SZ survey
PI: Fredrick High
PI Institution: University of Chicago

The South Pole Telescope (SPT) has detected clusters above a nearly uniform mass threshold over an extremely broad range in redshift by searching for the Sunyaev-Zel'dovich effect. The observed abundance of clusters from such a sample is directly sensitive to the growth function of matter perturbations over the majority of the history of the universe, and thereby provides crucial

constraints on dark energy with systematics that are complementary to traditional distance-based measures. The dominant source of uncertainty on dark energy constraints from this technique is our estimate of total cluster mass. We request HST observations of seven clusters of mass (0.3-1)x10^15 Msun at 0.93 < z < 1.2 in order to obtain weak lensing mass measurements of these systems. While the gas and dark-matter properties of clusters out to redshift z ~ 0.4 have been well studied, this is the first time this analysis has been extended to such high-mass clusters at z ~ 1. Empirically verifying whether these clusters have bulk matter properties similar to the better understood local samples is necessary for obtaining the best possible estimates of cosmological parameters. This is the critical high-redshift complement to our recently approved weak lensing observations of seven 0.6 < z < 0.9 clusters with HST Cycle 18, and ten 0.3 < z < 0.6 clusters using Megacam at the Magellan 6.5 m in Chile. The weak lensing mass estimates will be combined with existing SZ, Chandra and XMM, Spitzer/IRAC, and optical data that have already been obtained or are scheduled for later this year, as part of a multi-wavelength, multi-technique effort to measure cluster masses with minimal systematic error.

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Proposal Category: GO
Scientific Category: SOLAR SYSTEM
ID: 12478
Title: The Mysterious Redness of Saturn's Rings
PI: Jeffrey Cuzzi
PI Institution: NASA Ames Research Center

The origin of Saturn's rings remains unresolved. Are they primordial or recently formed? Did they originate from a Saturn system resident, or from some more distant heliocentric interloper? Understanding the composition of the rings may provide crucial clues to solving these puzzles. Saturn's rings are almost pure water ice, contaminated by unknown trace constituents that are strongly absorbing at UV wavelengths, making the rings slightly red. The Cassini spacecraft has been in orbit at Saturn since 2004, and has made remarkable discoveries, yet the composition of the material which provides this UV absorption remains unknown. Several diverse candidates are under discussion, allowing very different formation scenarios for the origin of the rings. Using the unique capabilities of HST to explore a critical range of the UV spectrum inaccessible to Cassini instruments, we propose a series of STIS spectral observations to determine the nature of these trace absorbers. We will use primarily G230L, with a small fraction of time devoted to G430L to strengthen our identifications.

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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12479
Title: Low-z Analogs of High Redshift Lyman Alpha Emitters
PI: Esther Hu
PI Institution: University of Hawaii

Lyman-alpha emitting galaxies with luminosities comparable to those of the highest redshift galaxies are first seen at z ~ 1. Unlike higher redshift Lyman-alpha emitters, the Lyman-alpha emission from these galaxies is hardly modified by the intergalactic medium, which makes it possible to study the galaxies' intrinsic properties. We propose to develop a sample of 100-200 such galaxies in the GOODS-N field lying in the redshift range z = 0.7 - 1.8.

This requires 24 1-orbit exposures with the G280L grism on the WFC3-UVIS. The sample will allow us to construct Lyman-alpha luminosity functions in this poorly studied redshift range and to determine how the Lyman-alpha emitters are drawn from the general galaxy population at these redshifts. We will determine how the Lyman-alpha lines correlate with Balmer line fluxes, star formation rates, extinctions, and metallicities using the wealth of imaging and spectroscopic information available for the intensively studied GOODS-N region. These templates will be valuable for studying what controls the escape of Lyman-alpha photons in the more luminous star forming galaxies, in interpreting the highest redshift Lyman-alpha emitters, and in understanding how their properties are modified by the intergalactic gas.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12480
Title: Characterizing a gravitational lens in the molecular Einstein ring SMG 18423+5938
PI: Chris Carilli
PI Institution: Associated Universities, Inc.

We propose a single orbit exposure of the strongly lensed submm galaxy (SMG), MM18423+5938, using WFC3 110W. MM1842 is the brightest SMG with a published spectroscopic redshift (z = 3.9296), and has an apparent star formation rate of order 1e4 Mo/yr. Recent EVLA observations reveal a complete Einstein ring for the CO emission, confirming the strong lensing hypothesis for MM1842. Using the CFHT, we have identified the lensing galaxy at the center of the CO ring, with z_phot ~ 1.0. MM1842 is the archetype, and best studied, of the new population of strongly lensed SMGs that have recently been identified in shallow, wide field submm surveys. These systems represent the formation of massive galaxies at high redshift in luminous starburst events. MM1842 presents a unique opportunity to study the physical processes involved in early galaxy formation at unprecedented physical resolution. The goal of this modest HST request is to obtain detailed information on the stellar distribution in the lensing galaxy. Such information is fundamental to accurate lens modeling of the system, as has been clearly demonstrated with the CASTLES HST survey. In parallel, we are performing high resolution imaging (0.1") of the very luminous CO, atomic fine structure line, and dust continuum emission from MM1842 with the EVLA and IRAM PdBI. Using the lens model, we can then trace back the gas distribution and dynamics in the source-plane at an effective physical resolution approaching 100pc. The proposed HST observations are crucial to constrain the lens model, and thereby enable a truly breath-taking, high physical resolution study of massive galaxy formation in the early Universe.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12481
Title: WISE-Selected Lyman-alpha Blobs: An Extreme Dusty Population at High-z
PI: Carrie Bridge
PI Institution: California Institute of Technology

We have recently discovered a new class of WISE-selected dusty Ly-alpha emitters (LAEs) and Ly-alpha ``blobs'' (LABs; >50 kpc). These systems have mid- and far-IR properties unlike other populations at z>2. They are likely

to be amongst the most luminous galaxies in the Universe, making them unique laboratories for studying feedback, gas processing and accretion. We propose a unified HST program of narrow-band Ly-alpha imaging, UV continuum broad-band imaging and near-IR imaging to improve our understanding of these rare systems and place them in context with the related populations of sub-mm galaxies, and Lyman-break galaxies. We request 15 orbits to image the complete sample of 15 WISE discovered LABs with WFC3 (F160W) and 20 orbits with the ACS ramp and broad-band filters to map the Ly-alpha morphology for the 4 largest and most luminous WISE LABs. The 0.5-kpc resolution ACS-ramp imaging will reveal the spatial distribution of their strong Ly-alpha emission, and will dissect their complex ISM on scales that are not possible to address from ground-based observatories. If powerful AGN outflows are at work the Ly-alpha morphology will be collimated, in contrast to star-burst driven winds which will have larger opening angles, and clumpy line-emitting structures. The near-IR WFC3 imaging will allow us to characterize the formation processes via an assessment of the morpholgy, environment, and stellar popuation of this cosmological signpost population.
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Proposal Category: GO
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12482
Title: Relative atmospheric compositions and metallicities of a multi-planet system
PI: Jean-Michel Desert
PI Institution: Harvard University

The Kepler mission has detected an amazingly rich diversity of extra-solar planet candiates. A large amount of them are grouped in multiple system, orbiting the same host star. We have now the opportunity to characterize and compare the diversity of exoplanetary worlds within one multiple system, and with planets from other systems, thus opening a new window to the field of comparative exoplanetology. We propose to observe the atmospheres of the two confirmed Saturn-like planets which orbit the same host star, Kepler-9b and Kepler-9c. The planetary atmospheres will be probed using transmission spectroscopy observations from 1.1 to 1.7 microns with HST/WFC3. When combined with results from Kepler, the WFC3 data will reveal the presence of water and methane absorption features for each planet. These molecules are expected to be present in gas phase in the warm atmopsheres of these objects. Comparing these observations to giant planet atmospheric models, the molecular abundances and the overall envelope metallicities can be retrieved since models are locked down to the Kepler measurements. Furthermore, the relative metallicity between these two planets can be derived. Such measurements help to constrain planetary formation and evolution theories. The presence of water in the earth atmosphere precludes such observations from the ground at the required precision since we intend to detect water absorption in the gas layer surrounding extrasolar planets. Only HST that can be used for this investigation.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12483
Title: What is the origin of the hottest known white dwarf?
PI: Klaus Werner
PI Institution: Universitat Tubingen, Institut fur Astronomie & Astrophysik

KPD0005+5106 is the hottest known white dwarf (Teff=200,000 K). It has a helium-dominated atmosphere with trace amounts of light metals. Our recent analysis places the star in a region of the HRD where very weak stellar winds prevent gravitational settling of heavy elements. Therefore, the surface composition allows to conclude on the evolutionary history. We speculate that KPD0005+5106 represents a third post-AGB evolutionary sequence, which is distinct from the canonical hydrogen-rich and hydrogen-deficient sequences. The star could be the long-searched progeny of the RCrB stars, which are believed to be the result of a double-degenerate merger. We found that the metal abundances in KPD0005+5106 are rather similar to those in RCrB stars, however, a claim on the evolutionary link is premature. The abundance determinations for KPD0005+5106 are afflicted with large errors because of the relatively large uncertainty in Teff. Our immediate aim is to use ionization balances of metals in order to determine Teff to high precision, which is a prerequisite to tightly constrain abundances. HST-UV spectroscopy is the only means to reach this goal.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12484
Title: STIS UV spectroscopy of a bright nova during its super soft X-ray phase
PI: Gregory Schwarz
PI Institution: American Astronomical Society

We propose ToO observations of one bright nova in outburst using the STIS echelle to obtain ultraviolet spectroscopy while the source is X-ray luminous. UV spectroscopy enables determination of ejecta physical properties, including the elemental abundances, ejecta mass, and structure. This information provides insight into the role of novae in the isotopic enrichment of the Interstellar Medium, pre-solar grain abundances, details on the mass and composition of the underlying white dwarf, and constraints on hydrodynamic modeling of the outburst. UV data are key to these analyses, providing the only opportunity to observe strong carbon lines in these objects as well as direct measures of the interstellar reddening. With slit spectroscopy from ~1100-3100 Angstroms, HST is currently the only facility that can provide these data. The data will complement our existing ground based optical, infrared and radio and Swift X-ray nova ToO programs providing continous spectral information from X-ray to the radio.
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Proposal Category: GO
Scientific Category: AGN/QUASARS
ID: 12485
Title: Extreme Variability, Proper Motions and High Energy Emission in the M87 Jet
PI: Juan Madrid
PI Institution: Swinburne University of Technology

The M87 jet is experiencing extreme optical/UV variability and very high energy emission that were never anticipated. HST-1, a knot along the M87 jet located at ~1" from the nucleus, has experienced unusual and repeated flaring at all wavelengths during the last decade. Exceptional brightness variability for a resolved component of an AGN jet has been recorded for HST-1. Hubble Space Telescope observations revealed that the NUV intensity of HST-1

increased by a factor of 100 between 1999 and 2005. Equivalent variability was recorded by Chandra, and the VLA. This is an unprecedented event that has only been observed in the M87 jet and has serious implications for models of jet variability and unified schemes of AGNs. Similarly, all three major observatories studying very high energy gamma-rays reported flaring of M87 in the very high energy regime in 2005, 2008, and 2010. We intend to take two epochs of observations of the M87 jet with STIS six months apart to determine the evolution of the rapidly changing M87 jet during Cycle 19. With these observations we aim to: study the physical origin of the flare, find new and longer periodicity for this event, and measure the impact of such an energetic burst on the outflow of an AGN jet. These new observations will build a template to be compared with AGN/blazar flares at higher redshift where knots and galaxy nucleus cannot be resolved. With the same dataset we will also determine new superluminal motions of knots along the M87 jet. We will share and correlate HST observations with data obtained by another eleven major observatories as part of a worldwide cooperation.
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Proposal Category: GO
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12486
Title: QSO Absorption Line Systems from Dwarf Galaxies
PI: David Bowen
PI Institution: Princeton University

We propose observing 6 QSOs who sightlines pass within 14 kpc of nearby (cz ~ 400-3300 km/s) faint [M_B = -15.3 to -17.7] blue dwarf galaxies, in order to study the UV absorption lines arising from the disks and halos of the dwarfs. Low mass, gas-rich galaxies are expected to have a pivotal role in providing feedback mechanisms for regulating galaxy evolution, and for enriching the intergalactic medium (IGM). Our observations are designed to answer a simple set of questions, including: do outflows exist from the majority of low mass galaxies, and how far do the halos extend before merging with the IGM? What are the kinematics of the warm diffuse gas, and are the bulk velocities sufficient for the gas to escape from the potential wells of the galaxies? What are the metallicities of the outflows, and are they high enough to significantly effect the metallicity of the IGM? Do the metallicities of the outflows agree with measurements from HII regions within the galaxy itself? And how do the characteristics of the absorption lines compare with the family of QSO Absorption Line Systems seen at high redshifts? That is, do dwarf galaxies contribute significantly to the population of absorbers at earlier epochs?
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12487
Title: Probing Population III Star Formation in a z=7 Galaxy
PI: Xiaohui Fan
PI Institution: University of Arizona

We propose to carry out deep WFC-3/F132N narrow-band imaging of the galaxy BDF-521 (z = 7.008+/-0.002) to measure the strength of He II 1640 emission line in this young galaxy at the end of reionization epoch. He II 1640 emission, if detected, will provide the first direct evidence of massive Population III (metal free) star formation in the early Universe. In a pilot program in Cycle-17, we obtained narrow-band imaging centered on HeII for the

galaxy IOK-1 at z=6.96, and found the He II flux to be 1.2+/-1.0 x 10^-18 ergs s^-1 cm^-2, corresponding to a 1-sigma upper limit of 2 M_sun/yr in Pop-III star formation rate (SFR) assuming a top-heavy IMF. This sensitivity is 2.5x deeper than for the best previous ground-based measurement, and illustrates the power of HST narrow-band imaging in probing the earliest star formation. In this cycle, we will continue this effort by targeting galaxy BDF-521 at z=7.01 using F132N which covers the HeII emission at the galaxy redshift. The ground based photometry implies that BDF-521 has an extremely blue continuum slope with f_lambda ~ lambda^-4, the bluest among all confirmed galaxies at z>6, suggestive of either extremely low metallicity and/or a complete lack of dust. Therefore, BDF-521 is the most promising candidate for Pop-III detection. Our new HST observations will be able to detect or place the most stringent upper limit of 0.6 M_sun/yr on the Pop-III SFR (1 sigma). We will also use short F125W broad-band observations to measure the rest-frame UV flux of BDF-521 in order to estimate its overall SFR, confirm the blue UV slope, and quantify the morphology, as well as provide continuum subtraction for narrow-band imaging.
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Proposal Category: SNAP
Scientific Category: COSMOLOGY
ID: 12488
Title: SNAPshot observations of gravitational lens systems discovered via wide-field Herschel imaging
PI: Mattia Negrello
PI Institution: Open University

We propose snapshot observation with WFC3/IR F110W of a large sample of candidate gravitational lens systems discovered via the two widest extragalactic surveys with Herschel, the Herschel Astrophysical Terahertz Large Area Survey (H-ATLAS) and the Herschel Multi-tiered Extra-galactic survey (HerMES). The snapshot observations will be used to confirm the efficiency of the submillimeter-based lens selection method down to lower sub-mm flux densities than tested so far and to (i) characterize the morphology of the lensing galaxy and construct a model for the light profile for the lens that will be used to disentagle the lens from the background source in longer wavelength imaging (ii) constrain the rest-frame optical flux of the background galaxy after the lens subtraction and, in those cases where the lensed source is detected, perform a source-image reconstruction to estimate the magnification factor (iii) detect and characterize the lensed source in galaxy cluster lensing events where the cosmic magnification is usually highest.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12489
Title: The Origin of Wind Variability in CSPNe and its Connection to OB Star Wind Variability.
PI: Derck Massa
PI Institution: Space Telescope Science Institute

Time series analyses of stellar wind lines are a primary tool for determining the nature and origin of structure in stellar winds. They have provided considerable insight into OB star winds and a recent analysis of a fragmentary FUSE time series demonstrated the presence of apparently similar variability in CSPNe winds. Building on these FUSE results, we request 5 STIS orbits to

follow the wind variability in the CSPNe NGC6543. The new data will allow us to verify whether the 4.1 hour time scale inferred from the FUSEdata is related to the rotation period of the star, and we will use wind lines from excited states, available in the STIS band, to determine whether the origin of the wind structure is rooted in the stellar photosphere. If true, this result would be at odds with currently accepted theories for the formation of CSPNe and would suggest a sub-surface convection zone as the origin of the wind activity. All of this is possible in just 5 contiguous STIS orbits because, while the wind in NGC6543 has the same terminal velocity as a typical OB star, it is 20-30 times smaller, resulting in a correspondingly smaller wind flushing time and rotation period.
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Proposal Category: GO
Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12490
Title: The WFC3 Mosaic of The Star-Forming Galaxy M51 in Paschen beta
PI: Jin Koda
PI Institution: State University of New York at Stony Brook

We propose WFC3/IR Paschen beta imaging of the entire star-forming disk of M51 in a 10-point mosaic. This proposal is motivated by a new picture of gas evolution in galaxies from our recent observations in carbon-monoxide (CO) emission, namely one driven by galactic dynamics. The Paschen beta and archival ACS/Halpha images will enable correction for extinction throughout the entire M51 disk, and show an unprecedented map of star forming activity across the entire galaxy. By comparing this map with our new CO intensity and velocity maps, we will (1) place star formation in this new context of gas evolution, (2) study the triggering of star formation by correlating the star formation efficiency of individual GMC with global galactic structures (such as observed spiral shear motions and local gas convergence), and (3) investigate the physics that underlie the Schmidt law by resolving the early-phases of star formation and its environment. The extinction-corrected map of star formation activity will become a reference for future calibration of other tracers of star formation activity and will have an unparalleled archival value.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12491
Title: Imaging the Crab nebula when it is flaring in gamma-rays
PI: Andrea De Luca
PI Institution: Instituto Universitario de Studi Superiori Pavia

One of the most intriguing results of the gamma-ray instruments currently in orbit has been the detection of significant variability from the Crab Nebula in Sept 2010. Such gamma-ray brightening lasted for several days during which the gamma-ray flux from the nebula appeared 3-5 times brighter than normal. More importantly, a critical reassessment of long term behavior of the Crab flux, clearly showed that both Agile and Fermi has already detected similar brightening s in October 2007 and in February 2009, pointing to a recurrence time of once per year. Thus, an ad hoc HST strategy must be put in place to be prepared to react promptly in case of a new brightening in gamma rays. In Sept we requested a DD observation which was promptly accepted and carried out. However, the lack of a suitable reference image hampered our efforts to

pinpoint sites of possible variability inside the nebula. Thus, while now we ask 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, we are also organizing a regular (monthly) monitoring of the source both in X-ray and optical through a joint Chandra-HST proposal.
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Proposal Category: GO
Scientific Category: COOL STARS
ID: 12492
Title: The Nature of the Binary Companions to the Blue Straggers in the Old Open Cluster NGC 188
PI: Robert Mathieu
PI Institution: University of Wisconsin - Madison

Blue straggler stars trace the interface between two great fields of astrophysics: stellar evolution and stellar dynamics. They define new stellar evolution pathways, and they challenge our understanding of star cluster dynamics and binary evolution. The discovery of many blue straggler binaries with long orbital periods in the old open cluster NGC 188 has focussed theoretical attention on three formation models: i) mass transfer in binary stars, ii) stellar collisions during dynamical encounters of multiple star systems, or iii) mergers of inner binaries in primordial triples driven by the Kozai mechanism. A critical discriminant between these ideas are the secondary stars of the blue straggler binaries. The mass-transfer scenario predicts white dwarf companions, while the collision and merger scenarios predict main-sequence companions. Ground-based spectra do not detect secondary star light, suggesting white dwarfs or low-mass main-sequence stars. Far-UV observations will distinguish these two types of companions for young blue stragglers in NGC 188. We propose to obtain precise photometry in the ACS/SBC F140LP, F150LP and F165LP bandpasses for 20 blue stragglers in NGC 188. These observations can detect WD companions with high significance, and also provide initial temperature determinations. Fifty years since their discovery, we still do not understand how blue stragglers form or evolve. The proposed observations can directly determine for the first time the origin of specific blue stragglers in a star cluster, and will be a definitive test of whether most blue stragglers form by mass transfer.
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Proposal Category: GO
Scientific Category: AGN/QUASARS
ID: 12493
Title: A Candidate Lensed Quasar at z=6.25
PI: Ian McGreer
PI Institution: University of Arizona

We have identified a candidate lensed quasar at z=6.25 through an ongoing Cycle 18 SNAP program surveying z~6 quasars with WFC3/IR imaging. The object is resolved into multiple components on subarcsecond scales; however, the shallow, single-band SNAP data does not provide a conclusive determination as to the nature of these components. We propose follow-up imaging with ACS/WFC F775W and WFC3/IR F105W. This imaging will test various lensing hypotheses for the observed components, and color selection in these two bands will easily discriminate foreground and background objects. Faint objects seen within 0.8'' of the quasar may be lensed images or possibly galaxies at the quasar redshift, indicating the late stages of merging activity. We will take advantage of the full field-of-view to identify companion galaxies to a quasar

at one of the highest redshifts known.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12494
Title: Thermal emission from the famous double pulsar J0737-3039
PI: Martin Durant
PI Institution: University of Florida

The unique double neutron star (NS) binary J0737-3039 contains two pulsars of which J0737A is expected to dominate the optical to X-ray spectrum. The two accurate clocks in the system have enabled sensitive tests of General Relativity and precise measurement of the orbital parameters and component masses. X-ray observations, mainly sensitive to a hot (polar cap) emission component, do not constrain the whole NS surface temperature well. There has been no optical/UV detection yet although our analysis shows that magnetospheric component in the optical is already ruled out by the optical limits. This opens up an opportunity to detect thermal emission in the FUV with HST. Even a non-detection, corresponding to a factor of six in temperature below the current limit, would require re-interpretation of the X-ray spectrum and will exclude possible internal re-heating mechanisms. Together with the precise mass determination, the measurement (or the limit on) the NS surface temperature will place stringent constraints on the equation of state for the superdense matter in the NS interior, providing a big scientific return from our short program.
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Proposal Category: GO
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12495
Title: Near-IR Spectroscopy of the Hottest Known Exoplanet, WASP-33b
PI: Drake Deming
PI Institution: NASA Goddard Space Flight Center

We propose to use the WFC3 G141 grism to measure the near-IR thermal spectrum (1.1-1.7 microns) of the transiting exoplanet WASP-33b. WASP-33b is the most strongly irradiated and hottest known exoplanet, and it is key to testing hypotheses on the origin of temperature inversions in the atmospheres of giant hot exoplanets. Moreover, it orbits an A-type star whose spectrum is quite different from most planet-hosting stars. Consequently, the existence or non-existence of a temperature inversion in this planet is key to understanding what are the principal wavelengths where stellar irradiance drives the inversion process. The observational signature of an inversion in WASP-33b will be the presence of the strong 1.4-micron water band in emission, rather than in absorption as for non-inverted exoplanets. That signature will be very clear and obvious in our high-precision spectroscopy of this scorching world, and there will be no degeneracies in the interpretation. Our observations will span the time of secondary eclipse for this transiting system. We will use a ratioing technique - proven by our ongoing Cycle-18 program - to cancel instrumental errors and achieve photon-limited precision for the spectroscopy. We propose utilizing the new WFC3 driftscan capability to collect vast numbers of stellar photons from this bright (V= 8.3) system with high observing efficiency. Our observations will thereby produce some of the most precise exoplanet spectroscopy ever achieved.
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Proposal Category: GO
Scientific Category: AGN/QUASARS
ID: 12496
Title: A Quasar-Starburst Merger System at z=6.2 ?
PI: Ran Wang
PI Institution: University of Arizona

Observations of high-redshift quasars probe the growth of supermassive black holes and their connections to galaxy formation at the earliest epoch. We have been carrying out a systematic survey of the star formation and ISM properties in the host galaxies of z~6 quasars using millimeter dust continuum and molecular CO emission. In this survey, we recently discovered the first z~6 quasar-starburst merger system: radio-loud quasar CFHQS J1429+5447 (z=6.2) is detected as a bright 3.4 mJy source in millimeter continuum; high resolution EVLA imaging of CO(2-1) transition reveals two distinct peaks separated by 1.2" (6.9 kpc), and ~50 km/s in velocity space, strongly suggesting that this is a merging system with two intense star forming components, only one of which is in the active quasar phase. We propose deep HST ACS/F775W and WFC3/F105W, F140W observations to confirm the merger nature, and measure the size, morphology, UV-based star formation rate, and constrain the UV continuum slope of both the quasar host galaxy and its merging companion galaxy. In addition, we will search for faint i-dropout galaxies and test the model prediction that luminous high-redshift quasars reside in highly overdensed environment. Comparison of our HST and mm/CO observations with detailed cosmological simulations of high-redshift quasar formation will place this unique system in the evolutionary sequence of SMBH/galaxy coevolution, and test models of quasar formation. The proposed observation of CFHQS J1429+5447 also provides an important test case for the future high-z quasar host galaxy imaging with HST/JWST and ALMA.
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Proposal Category: GO
Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12497
Title: Constraining Stellar Feedback : A Census of Shock-ionized Gas in Nearby Starbursts Galaxies.
PI: Sungryong Hong
PI Institution: University of Massachusetts

Stellar feedback is one of the most important engines of galaxy formation and evolution. However, the observational constraints are not yet established. We propose to investigate this problem by observing 2 nearby star-forming galaxies, selected to fill an unexplored niche in the key 2-dimensional parameter space of host galaxy’s stellar mass and star formation rate density. From the WFC3 narrow-band observations in the light of H-alpha, H-beta, [OIII], and [SII], we will : (1) produce the line diagnostic diagrams, [O III](5007)/H-beta vs. [S II](6716+6731)/H-alpha, (2) discriminate the feedback-driven shock-ionized component from the ionized gas, (3) measure the energy budget of the shocks from star forming feedback. Those observations, joined by our previous data and studies on nearby starburst galaxies, will yield the efficiency of the feedback, i.e. the fraction of the star formation’s mechanical energy transported out of the starburst site rather than radiated away, as a function of both stellar mass and star formation rate intensity. The high angular resolution of HST is crucial for separating the shock fronts (~10pc = 0.2’’ at 10 Mpc) from the photo-ionized regions. This project will provide the quantitative foundation of stellar feedback and a

gauge for determining the role of feedback in the energetics, structure, and star formation history of galaxies.

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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12498
Title: Did Galaxies Reionize the Universe?
PI: Richard Ellis
PI Institution: California Institute of Technology

We propose to use the unique power of ultra-deep WFC3/IR imaging to resolve the long-standing question of whether and when young galaxies reionized the Universe. HST can demonstrably address this important goal by establishing whether: (i) there is a sustained evolving population of star-forming galaxies that can be convincingly measured via robust multi-filter detections in the redshift range 7 < z < 10; (ii) the population produces sufficient ultraviolet luminosity density through well-determined luminosity functions to faint limits at z~7 and z~8; (iii) a large enough fraction of ionizing photons can escape their host galaxies as determined from bias-free precise measures of the slopes of their UV continua. We show, via a detailed analysis of the existing and ongoing WFC3/IR surveys, and a range of simulations, that these issues can only be addressed through a strategic new WFC3/IR imaging campaign in the Hubble Ultra Deep Field (HUDF). Our proposed, highly-focused, strategy exploits the existing and planned ACS+WFC3 imaging to the full, but transforms our ability to study the number density of z~7-10 sources and the detailed astrophysical properties at z~7-8. The required investment of 128 orbits, primarily in F105W and the hitherto unexploited F140W filter, will ensure HST advances our understanding of this final frontier in cosmic history prior to the launch of JWST.

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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12499
Title: Proper Motions of Massive Stars in 30 Doradus
PI: Daniel Lennon
PI Institution: Space Telescope Science Institute - ESA

We propose an ambitious proper motion survey of massive stars in the 30 Doradus region of the Large Magellanic Cloud using the unique capabilities of HST. We will derive the directions of motion of massive runaway stars, searching in particular for massive stars which have been ejected from the central very massive cluster R136. These data will be combined with radial velocities from the VLT-FLAMES Survey of the Tarantula Nebula and with atmospheric analyses and stellar evolution models to constrain their origins. We will also search for very young isolated massive stars to test models of single-star formation. This work is highly relevant to star formation, cluster dynamics, the origin of field WR stars and GRBs, the creation of very massive stars by runaway mergers, and the possible formation of intermediate-mass black holes.

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Proposal Category: GO
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12500
Title: High-resolution UV studies of SAURON galaxies with WFC3:

constraining recent star formation and its drivers in local early-type galaxies
PI: Sugata Kaviraj
PI Institution: Imperial College of Science Technology and Medicine

A significant recent discovery, using survey data in the rest-frame ultraviolet (UV), is the unambiguous detection of widespread, low-level recent star formation (RSF) in nearby early-type galaxies (ETGs). Its extreme sensitivity to young stars makes the UV the ideal tool to accurately quantify the weak star formation in ETGs, which were traditionally thought to be evolving largely passively. We aim to combine the UV capabilities of WFC3 with the powerful SAURON survey - which offers optical integral-field spectroscopy of local ETGs - to study RSF in ETGs in unprecedented detail. Our targets are a subset of SAURON with fully mapped molecular CO and signatures of star formation. For each target we aim to (1) use a pixel-by-pixel analysis to spatially map the properties of the young stars (ages/mass fractions/metallicities) (2) calculate ages/metallicities of individual globular clusters to probe the galaxy's mass assembly over time (3) combine UV-derived RSF estimates with CO gas maps to study the star formation law on unprecedentedly small scales (4) compare the age-dated substructure to numerical simulations of minor mergers to constrain characteristics of the last merger event (e.g. mass ratios, satellite gas fractions) in ETGs that are likely to be merger remnants. The research leverages our past work with UV data (e.g. GALEX) and a published WFC3 study of NGC 4150, which we use to explicitly demonstrate the scope and quality of the science results. The unique WFC3 combination of high UV sensitivity and spatial resolution are critical and we demonstrate why this proposal cannot be fulfilled using any other facility. The proposal targets 10 ETGs with 15 orbits.
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Proposal Category: GO
Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12501
Title: COS G140L CENWAV = 800, a gapless low astigmatism mode for observations to the Lyman Limit
PI: Stephan McCandliss
PI Institution: The Johns Hopkins University

The demonstrated sensitivity of COS to wavelengths below 1150 Angstroms has opened a new window to the universe, enabling a number of unique science investigations in a bandpass hitherto inaccessible to Hubble. Here we propose to calibrate a new operating mode for G140L with a central wavelength setting CENWAV = 800 Angstroms, which will place the entire spectrum, from the Lyman edge (near 912 Angstroms) to the CsI cutoff (near 1850 Angstroms), onto Segment A. The proposed new mode moves the 900 – 1100 Angstrom region into the low astigmatism portion of the spectral coverage and will produce an unprecedented improvement in sensitivity to low flux objects observed in this bandpass. Most importantly it will enable the efficient utilization of Hubble orbits for executing exciting new science programs that are currently background limited.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12502
Title: From the Locations to the Origins of Short Gamma-Ray Bursts

PI: Andrew Fruchter
PI Institution: Space Telescope Science Institute

While long-duration gamma-ray bursts (LGRBs) result from the collapse of massive stars, the progenitors of short-duration gamma-ray bursts (SGRBs) are still unknown. Although SGRBs are widely thought to result from the inspiral of compact binaries, this is a conjecture. SGRBs have been found in elliptical galaxies, Abell Clusters, star-forming dwarfs and spirals. Analysis of our Cycle 16 and Cycle 17 programs shows that the vast majority of SGRBs lie off of the rest-frame UV light (lambda < 400nm) of their hosts, and may even be more widely distributed than the red light (lambda > 600 nm). These results may be an indication that the progenitors of SGRBs have significant velocities. We will use two lines of attack to obtain substantial new insight into the origins of SGRBs. 1) WFC3 IR imaging of eleven hosts will nearly double the number of hosts with HST imaging in the rest-frame red. This new sample is large enough to turn the statistical suggestion already seen in the red light distribution into a statistical certainty, and would strongly imply that SGRBs are formed from compact binaries. Additionally if some of these bursts continue to show no evidence of an underlying host, models which predict neutron-star binaries with large velocities would be favored. 2) If an SGRB goes off in a nearby elliptical we will trigger a target of opportunity. The discovery of a globular cluster at the site of the explosion would provide revolutionary evidence that SGRBs are formed from compact binaries.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12503
Title: The True Origin of Hypervelocity Stars
PI: Oleg Gnedin
PI Institution: University of Michigan

We propose to obtain WFC3 images of 4 hypervelocity stars in the Galactic halo, in order to conclusively establish their origin. This will be a final epoch of a long-term program to measure precise proper motions in an absolute inertial frame. The origin of these unique stars with extremely large positive radial velocities, in excess of the escape speed from the Galaxy, is consistent only with being ejected by the massive black hole at the Galactic center. Reconstructing the full three-dimensional space motion of these stars, through astrometric proper motions, provides a unique opportunity to measure the shape of the triaxial dark matter halo, at larger distances than is afforded by tidal streams. In Cycles 15 and 17 our team obtained two epochs of observations for these stars with ACS. The accuracy of the proper motion measurement was affected by the CTE degradation in ACS and the unexpected change in the PSF after SM4. The CTE error of HVS3 was unfortunately amplified by the need to use different guide stars and take the second-epoch observations at a 180 degree different orientation. We request third-epoch observations for 4 targets with WFC3 to double the proper motion baseline to 5-6 years and to reduce the systematic error using our newly-developed CTE correction. The new measurement will conclusively confirm or reject the Galactocentric origin of HVSs.
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Proposal Category: GO
Scientific Category: COOL STARS
ID: 12504
Title: Bridging the Brown Dwarf/Jupiter Temperature Gap with a

Very Cold Brown Dwarf
PI: Michael Liu
PI Institution: University of Hawaii

Residing at the extremes of low mass, luminosity and temperature, brown dwarfs serve as laboratories for understanding gas-giant extrasolar planets. Still, until a few months ago, the coolest brown dwarf known was ~4 times warmer than Jupiter. We have now identified the nearby T9.5 dwarf CFBDSIR J1458+10 as a 0.11" physical binary. As established by our near-IR parallax to the system, the very blue secondary component is the coldest and least luminous object outside the solar system directly imaged. With an estimated temperature of ~350-400 K, it is the coolest known brown dwarf by ~150 K and the least luminous by a factor of 4-5. As such, CFBDSIR J1458+10B provides a gateway for measuring the properties of substellar objects at previously unexplored extremes. We propose to use HST to obtain far-red and near-IR medium-band photometry of CFBDSIR J1458+10B and to measure its 0.8-1.6 micron spectral energy distribution. Theoretical models predict this wavelength range to be highly sensitive to completely new physical processes not yet seen in brown dwarfs, including the formation of photospheric water clouds and the disappearance of the very broad potassium line that dominates the far-red spectra of T dwarfs. The impact of these changes on the emergent spectrum, however, depends on very uncertain input physics. Our observations will sensitively probe these processes, with the A and B components providing a pure temperature probe at constant metallicity and age.
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Proposal Category: GO
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12505
Title: COS observations below 1150 Å with R > 10,000: Calibrations for a new G130M/1222 central wavelength
PI: Steven Penton
PI Institution: University of Colorado at Boulder

We propose to fully calibrate a new COS/G130M wavelength setting. This setting, G130M/1222, places Geocoronal Lya on the detector gap (to mitigate FUV detector gain sag) and covers the astrophysically important UV bandpass of 1065-1327 Å. At the focus mechanism position requested, this mode provides 4-7 times the resolution of the G130M/1055 and G130M/1096 central wavelength settings at the same sensitivity. The sensitivity, waveband, and increased resolution of the G130M/1222 central wavelength (R=14,000 at 1065 Å, 8,000 at 1222 Å, and 6,800 at 1369 Å) is beneficial to many UV scientific studies, including, but not limited to, molecular hydrogen in planetary nebulae and translucent clouds, the HeII lyman-alpha forest in the epoch of HeII re-ionization, AGN intrinsic absorbers and high-ionization outflows, low-redshift IGM, galaxy halos, galaxy feedback, and the WHIM using O VI, MgX, NeVIII, Lyman beta, and other important atomic and molecular transitions. At 1100 Å, this mode has ~10 times the effective area of FUSE (per channel) with almost non-existent detector background. This proposal is designed to completely calibrate this wavelength setting with minimal use of STScI personnel and resources.
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Proposal Category: GO
Scientific Category: STAR FORMATION
ID: 12506
Title: A Precise Mass-Luminosity-Temperature Relation for Young

Stars
PI: Adam Kraus
PI Institution: University of Hawaii

The fundamental properties of young stars (masses, luminosities, and temperatures) are very poorly understood in comparison to their older field counterparts. The standard method for calibrating these properties is to monitor the orbits of binary systems and measure their dynamical masses, but only a handful of well-determined dynamical masses are known for low-mass (<1 Msun) stars. We are conducting an ongoing monitoring campaign to expand the sample of precise visual binary masses from ~5 to ~50 using a new high-resolution imaging technique (nonredundant mask interferometry) to monitor very short-period systems that can't be resolved with other techniques. However, the inaccessibility of these systems makes it difficult to determine component properties from the ground. We propose a 16-orbit WFC3/UVIS imaging campaign to observe 16 systems that are near maximum separation. We know precise component positions at any epoch from our orbit fits, so we can exploit the stable HST PSF to deconvolve the optical photometry for these systems, even though they are separated by <60 mas. Furthermore, the targets' brightness and the speed of the subarrayed WFC3/UVIS let us obtain observations in 11 filters within a single orbit, efficiently characterizing each component's broadband SEDs from the near-UV to the far-red and measuring emission line fluxes in Halpha and Ca H&K. These comprehensive SEDs will yield component temperatures and identify any excesses on the individual stars resulting from accretion and activity. Our results will place the the individual stars unambiguously on the HR diagram, allowing direct comparison of our dynamical masses to theoretical predictions.
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Proposal Category: GO
Scientific Category: STAR FORMATION
ID: 12507
Title: The Formation and Fundamental Properties of Wide Planetary-Mass Companions
PI: Adam Kraus
PI Institution: University of Hawaii

Over the past five years, direct imaging surveys for extrasolar planets have discovered a small but significant number of planetary-mass companions at separations >50 AU from their host stars. These wide companions pose a significant challenge to models of planet formation and of substellar atmospheres and evolution, and there are still many puzzling questions regarding their formation and fundamental properties. To address these open topics, we propose a WFC3 optical imaging survey for 25 orbits to study 12 planetary-mass companions. Our survey has three goals: 1) to use UBV and narrowband Halpha photometry to determine if (and how much) these companions are accreting out of circumplanetary disks, 2) to use broadband optical photometry to measure their temperatures and luminosities by estimating their optical spectral types, and 3) to exploit the stable HST PSF to test whether any of the companions are marginally resolved binary pairs. None of these goals can be pursued from the ground, where high-resolution observing techniques are limited to near-infrared wavelengths and yield less stable PSFs.
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER

ID: 12508
Title: Constraining the evolutionary state of the hot, massive companion star and the wind-wind collision region in Eta Carinae
PI: Theodore Gull
PI Institution: NASA Goddard Space Flight Center

Our primary goal is to constrain the physical properties of Eta Car's wind-wind collision region and the properties of Eta Car B, the hot, very massive secondary companion that is hidden from our view. We propose to do this by measuring the forbidden emission lines in the extended, interacting wind structures resolved in the inner 1.5 arcseconds region. As the mass-loss structures evolve across the 5.54-year orbital period, we will selectively map their spatial and velocity changes at critical phases using the spatial resolution of HST and moderate spectral resolving power of the STIS to generate spatial (2-D), velocity (1-D) data cubes of regions of critical collisional densities. We will use these spatial-velocity data cubes to drive ongoing 3-D models of the interacting winds, adding radiative transfer. We will (A) strongly constrain the 3-D mass loss from the system and (B) determine the properties of Eta Car B, the source of FUV radiation and the driving wind creating the X-ray emitting cavity out of the dominating wind of Eta Car A.
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12509
Title: Peering into the Cat's Eye with STIS
PI: Martin Guerrero
PI Institution: Instituto de Astrofisica de Andalucia (IAA)

Planetary Nebulae (PNe) are formed by interactions of the current fast stellar wind and the previous slow AGB wind. In this scenario, the bright PN shell consists of the swept-up AGB wind, while the central cavity contains shocked fast wind. The structure and evolution of the so-called hot bubble is largely dependent on the physical processes occurring at the interface between the 10^4 K nebular shell and the >10^6 K interior gas. Among the PNe whose extended X-ray emission has been detected and analyzed in detail with Chandra or XMM data, the Cat's Eye Nebula (NGC 6543) is the best resolved and has the least non-uniform extinction, and thus provides the best laboratory to study the interaction of the fast stellar wind with the surrounding nebula, i.e. the interface between hot and cold media. We request HST STIS UV and optical spectroscopic observations of the Cat's Eye Nebula to: (1) use N V and C IV lines to determine the precise location of the interface between the hot interior and the cool nebular shell, and (2) use nebular lines to determine the temperature and density structure of the adjacent nebular shell. These observations, together with our Chandra and FUSE observations, provide the first complete description of the interface and its boundary conditions that will allow us to investigate the underlying physical processes, such as heat conduction, turbulent mixing, and mass loading. Understanding the interface physics is important for a wide range of astronomical objects where hot gas is in contact with cooler gas, e.g. supernovae remnants, wind-blown bubbles, superbubbles, and interstellar/intergalactic medium.
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Proposal Category: GO
Scientific Category: AGN/QUASARS

ID: 12510
Title: Quasar Ton 34 with steepest far-UV break known has entered new bal QSO phase
PI: Luc Binette
PI Institution: Universidad Nacional Autonoma de Mexico (UNAM)

Using HST-COS/G140L and HST-STIS with G230L and G430L, we request 4 orbits to observe the QSO Ton34 (z=1.928). Among archive HST/FOS spectra, Ton34 shows an unusually steep FUV drop, equivalent to a powerlaw of index -5. At shorter wavelengths, only an extremely noisy IUE spectra exists. The FUV observations would provide us with a unique window to test whether Ton34 remains EUV deficient at shorter wavelengths or shows instead the onset of a second peak in the extreme (E)UV, explaining how photoionization can still account for its high excitation emission lines of CIV, OVI… With the STIS MAMA-NUV spectrum, we will also study and confirm whether low excitation EUV BLR lines such as the permitted lines of OII + OIII (835Å) or NIII (686Å) are present and as strong as reported from an earlier but noisy IUE spectrum (this would possibly favor shock excitation). Using archive optical spectra near the CIV region (from years 1988 and 2006), we recently showed that Ton34 is currently undergoing a strong BalQSO phase, the first case reported among bright quasars. A priority of the proposed STIS NUV observations will be to look for the presence of blueshifted absorption troughs near Ly-alpha or OIV (as well as any change in the continuum's sharp break) using the STIS/G430L spectrum.
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Proposal Category: GO
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12511
Title: Determining the Atmospheric Properties of Directly Imaged Planets
PI: Travis Barman
PI Institution: Lowell Observatory

For the first time, a multi-planet system has been directly imaged. The young star HR 8799 is home to four massive planets (5 to 10 Jupiter-masses) that have all been imaged from the ground, confirmed as proper motion companions, and orbital motion is clearly detected. This system offers a unique opportunity to study planetary atmospheres in detail for a coeval set of objects that also likely have very similar abundances. Despite ground based detections at J, H, K, L, and M-band, there remain significant degeneracies when fitting synthetic spectra to this limited data set. We, therefore, are requesting WFC3 medium band photometric observations from 0.8 to 1.6 microns to better characterize these planets. These proposed data will allow us to distinguish between various atmospheric cloud models and allow robust effective temperature and surface gravity determinations to be made.
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Proposal Category: GO
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12512
Title: Debris Disk Chemistry from Spatially Resolved Spectroscopy
PI: Alycia Weinberger
PI Institution: Carnegie Institution of Washington

We propose the first coronagraphic spectroscopy of three circumstellar debris disks. These observations will enable the only possible studies of their cold

dust grain compositions. Spectroscopy of their dust will provide detailed reflectivities from 3500 - 9500 Angstroms, an unprecedentedly large wavelength grasp. We will be able to estimate the organic-to-silicate ratio of the dust and constrain its place of formation and subsequent processing. Debris dust arises from the collisions and evaporation of planetesimals, and it is these same planetesimals which are the building blocks for planets. The compositions and dynamics of planetesimals may reflect and affect the final composition and architectures of the planetary systems. All of our targets have been imaged previously with HST. All have complex broad-band colors that change with location in the disk and that may signal the presence of dynamical perturbations or compositional processing. We have demonstrated in a previous program how to use STIS for spatially resolved disk spectroscopy. We now propose to apply our technique to study the compositions of essentially all known edge-on disks bright enough to observe with STIS.

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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12513
Title: Stellar Life and Death in M83: A Hubble-Chandra Perspective
PI: William Blair
PI Institution: The Johns Hopkins University

The grand-design spiral starburst galaxy M83 is nearby (4.5 Mpc), face-on, and the host to six SNe since 1923--making it an exceptional laboratory for studying the life cycle of massive stars. Starting with their birth in star clusters, continuing with dissolution of most clusters and transfer of thestars to the field, and ending with their demise as SNe to produce a population of SNRs and X-ray binaries, massive stars provide most of the ``action" in galaxies. Data from two Early Release Science fields demonstrate WFC3's value for exploring the environments of massive stars and finding supernova remnants in M83. We propose broad- and narrow-band WFC3 imaging of an additional five fields to complete coverage of M83's bright optical disk. When combined with a deep (750 ks) Chandra observation now underway and a recently approved deep radio survey from ATCA, our program will provide the most detailed multiwavelength study of any spiral galaxy. Our primary goals are to: 1) dissect how clusters form and then dissolve into the field, using precision age dating techniques WFC3 enables; 2) investigate the X-ray binary population by identifying optical counterparts and exploring their local star-formation history; 3) characterize an unprecedented sample of over 300 SNRs and use them as probes of galactic structure; and 4) relate clusters and SNRs to the extensive diffuse X-ray emission in M83. Besides these specific goals, this data set will have great archival value for other many future studies, including identification of the progenitors of new SNe--expected every decade or so in this supernova factory.

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Proposal Category: GO
Scientific Category: STAR FORMATION
ID: 12514
Title: Imaging Newly-identified Edge-on Protoplanetary Disks in Nearby Star-Forming Regions
PI: Karl Stapelfeldt
PI Institution: Jet Propulsion Laboratory

Edge-on, optically thick circumstellar disks have been imaged at subarcsecond

resolution around about a dozen nearby young stellar objects (YSOs). In these systems the central star is occulted from direct view, bright star image artifacts are absent, and the disk reflected light is clearly seen. Comparison of HST edge-on disk images with scattered light models has allowed key structural parameters such as the disk outer radius, vertical scale height, radial flaring profile, total mass, and dust grain properties to be determined. Edge-on disks have been systematically undercounted to date: although 15% of young stars should statistically be occulted by their disk, the observed frequency is < 2%. The Spitzer Space Telescope has provided the first good measurements of the spectral energy distributions for the currently known edge-on disks, finding a characteristic double-peak morphology and showing the sources to be strongly underluminous at wavelengths <3 microns. Using these as templates, we have identified a large sample of new edge-on disk candidates among more than 2000 YSOs cataloged in Spitzer legacy surveys of nearby molecular clouds. Twenty-one of these are high-confidence identifications with spectroscopic confirmation as YSOs and are optically visible. We propose an R+I band imaging survey of this sample to reveal their disk and jet structures. Image modeling will reveal the full diversity of disk vertical structures that trace the settling of dust grains to the disk midplane - the key first step on the road to planet formation. This program will more than double the number of edge-on disk sources with high-fidelity images suitable for scattered light modeling.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12515
Title: Probing the outer limits of a galactic halo - deep imaging of exceptionally remote globular clusters in M31
PI: Dougal Mackey
PI Institution: Australian National University

Globular clusters (GCs) are fossil relics from which we can obtain critical insights into the formation and growth of galaxies. As part of the ongoing Pan-Andromeda Archaeological Survey (PAndAS) we have discovered a group of exceptionally remote GCs in the M31 halo, spanning a range in projected galactocentric distance of 85-145 kpc. Here we apply for deep ACS imaging of 13 such targets, which will allow us to study their constituent stellar populations, line-of-sight distances, and structural parameters. Our measurements will facilitate the use of these GCs as a unique set of probes of the exceptionally remote halo of a large disk galaxy, opening up a completely new area of parameter space to observational constraint. Comparing the properties of our targets with more centrally-located objects will provide a much clearer picture of the M31 GC population than is presently available, while comparison with the outermost Milky Way GCs will further elucidate well-known disparities between the two systems and offer vital clues to differences in their assembly. In addition, our measurements will substantially augment a broad swathe of science that is presently underway - including probing the dark mass distribution in M31 at very large radii, and investigating the detailed chemical composition of M31 GCs via high-resolution integrated-light spectroscopy.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12516
Title: COSMIC-LAB: Double BSS sequences as signatures of the

Core Collapse phenomenon in star clusters.
PI: Francesco Ferraro
PI Institution: Universita di Bologna

Globular Clusters (GCs) are old stellar systems tracing key stages of the star formation and chemical enrichment history of the early Universe and the galaxy assembly phase. As part of a project (COSMIC-LAB) aimed at using GCs as natural laboratories to study the complex interplay between dynamics and stellar evolution, here we present a proposal dealing with the role of Blue Straggler Stars (BSS). BSS are core-hydrogen burning stars more massive than the main-sequence turnoff population. The canonical scenarios for BSS formation are either the mass transfer between binary companions, or stellar mergers induced by collisions. We have recently discovered two distinct and parallel sequences of BSS in the core of M30 (Ferraro et al. 2009, Nature 462, 1082). We suggested that each of the two sequences is populated by BSS formed by one of the two processes, both triggered by the cluster core collapse, that, based on the observed BSS properties, must have occurred ~1-2 Gyr ago. Following this scenario, we have identified a powerful "clock" to date the occurrence of this key event in the GC history. Here we propose to secure WFC3 images of 4 post-core collapse GCs, reaching S/N=200 at the BSS magnitude level, in order to determine the ubiquity of the BSS double sequence and calibrate the "dynamical clock". This requires very high spatial resolution and very high precision photometry capabilities that are unique to the HST. The modest amount of requested time will have a deep impact on the current and future generations of dynamical evolutionary models of collisional stellar systems.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12517
Title: COSMIC-LAB: Hunting for optical companions to binary MSPs in Globular Clusters
PI: Francesco Ferraro
PI Institution: Universita di Bologna

As part of a project (Cosmic-Lab) aimed at using Globular Clusters (GCs) as natural laboratory to study dynamics and stellar evolution, here we present a proposal focussed on binary Millisecond Pulsars (MSPs). We propose to search for the companion stars to binary MSPs in 4 GCs (namely NGC6440, M5, NGC6838 and NGC6544), where recent radio observations have found particularly interesting objects. To achieve this challenging goal, we intend to exploit the imaging capabilities of the WFC3 and a suitable observing strategy, thus to secure deep, multi-band, time-resolved datasets where even the faintest companions can be identified. This program is the result of a large collaboration among the major groups (lead by Freire, Ransom, Stairs and Possenti) which are performing extensive MSP search in the radio bands, and our group which has a large experience in high-precision stellar photometry and astrometry in crowded stellar fields. This collaboration already produced a number of outstanding results: 4 of the 7 optical counterparts to binary MSP companions known to date in GCs have been discovered by our group. The observations here proposed will (1) easily double the existing sample of known MSP companions, allowing the first meaningful approach to the study of the formation, evolution and recycling process of pulsars in GCs; (2) constrain the incidence of collisionally induced MSPs; (3) constrain the mass of the neutron star, thus opening the possibility (in the case of NGC6440 and M5) to identify the most massive NS ever measured, with a huge impact on the equation

of state of the matter at nuclear equilibrium density.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12518
Title: A New Lead on the White Dwarf Initial-to-Final Mass Relation
PI: Quentin Parker
PI Institution: Macquarie University

Any association between a planetary nebula (PN) and a Galactic open star cluster is an extremely valuable and potent astrophysical tool. This is because the accurate (<10%) cluster distance, as determined from a high quality color-magnitude diagram (CMD), constrains the physical parameters of the PN and its central star (CSPN) to exceptional precision. The age, and hence mass of the progenitor star can also be very tightly constrained from cluster isochrones. CSPN photometry also allows precise determination of its intrinsic luminosity and mass. The mass of the progenitor star, which can be related to the chemistry of the resulting PN (from spectroscopy), provides a rare additional datum for the fundamental white dwarf (WD) initial-to-final mass relation (IFMR) which intimately links WD properties to their main-sequence progenitors. A robust IFMR is a key component of using WD luminosity functions to constrain the age of the Galactic disk (field WD population) and open clusters (cluster population) and is also key to the build up of carbon and nitrogen in galaxies. We have discovered a unique PN/open cluster association to add to the IFMR. This single-object proposal is designed to exploit the science inherent in this remarkable discovery.
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Proposal Category: SNAP
Scientific Category: COOL STARS
ID: 12519
Title: Newly Discovered LMC Preplanetary Nebulae as Probes of Stellar Evolution
PI: Raghvendra Sahai
PI Institution: Jet Propulsion Laboratory

Pre-Planetary nebulae (PPNs), dying stars in transition between the AGB and planetary nebula (PN) evolutionary phases, hold the key to our understanding of the late evolutionary stages of (1-8) solar mass stars. Imaging surveys of Galactic young PNs and PPNs with HST show that the fraction of round objects is insignificant, whereas bipolar and multipolar morphologies abound, implying a dramatic but poorly understood transformation of the mass-loss process during the PPN phase. But the lack of reliable distances for most of these objects means that many key properties of these objects such as luminosity, dynamical time-scales, and masses cannot be determined, making it impossible to address many fundamental questions related to their evolution. In fact, a small sub-class of Galactic PPNs appear to be apparently very long-lived (with dynamical ages of >6000 years), providing a challenge for single-star stellar evolution theory because the latter predicts a very short lifetime for this phase (about 1000 yr or less). We therefore propose a pilot SNAPshot imaging survey of a small sample of spectroscopically-confirmed PPNs in the LMC with ACS/WFC. The well-known distance to the LMC will enable us to determine their sizes (and thus nebular ages) and luminosities unambiguously, providing compelling tests of stellar evolution models. The discovery of long-lived PPNs in the LMC from this survey will provide strong support for the much debated

binary hypothesis as the correct explanation for why the majority of PNs and PPNs are bipolar, multipolar or show other varieties of aspherical morphologies, even though the mass-loss envelopes of the progenitor AGB star are generally round.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12520
Title: Testing Rotational Mixing in Massive Stars: Boron in the Galactic Open Cluster NGC 3293
PI: Charles Proffitt
PI Institution: Computer Sciences Corporation

Recent observational advances have shown that chemical mixing in the envelopes of early-B stars is more complex than had previously been realized. The abundance patterns seen do not match the simple theoretically expected patterns, and there appear to be processes other than rotation that can also cause mixing. These complicating effects make it difficult to test or calibrate current stellar evolution models that include rotation with the currently available data, especially as most existing boron observations are biased towards intrinsically slow rotating stars. We have identified a sample of near-turnoff stars in the 10 Myr open cluster NGC 3293 which can now be efficiently observed with the COS G185M setting in which the earliest stages of rotationally driven mixing should have noticeably depleted the surface boron abundances. These observations will place stringent new constraints on models of rotationally driven mixing in early-B stars.
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Proposal Category: SNAP
Scientific Category: AGN/QUASARS
ID: 12521
Title: The Frequency and Demographics of Dual Active Galactic Nuclei
PI: Xin Liu
PI Institution: Harvard University

Dual Active Galactic Nuclei (AGNs) are actively accreting supermassive black hole (SMBH) pairs co-rotating in merging galaxies with separations of less than a few kpc. Despite decades of searching, and strong theoretical reasons to believe they exist, unambiguously confirmed dual AGNs are surprisingly scarce, which contradicts naive Lambda-CDM prediction. We propose a SNAP survey with WFC3 to systematically identify dual AGNs. We exploit a well-tested technique, which has a success rate of 10-25% at least, based on the selection of AGNs with double-peaked [O III] emission lines. We have reached the limits of what we can learn from the ground. We request HST's superb image quality in both optical and NIR and its high sensitivity to explore a new regime of dual AGNs at a more advanced merger stage, inaccessible from the ground or any other space facility. With the proposed observations well suited for a SNAP program, we will determine the frequency of dual AGNs down to the smallest scales attainable with current facilities to test the hierarchical merger paradigm, and explore the demographics of dual AGNs as a function of separation to better understand the accretion and evolution of SMBH pairs in merging galaxies.
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Proposal Category: GO

Scientific Category: COSMOLOGY
ID: 12522
Title: Testing feedback with z=1 star-forming galaxies
PI: Nicolas Bouche
PI Institution: University of California - Santa Barbara

Theoretical models of galaxy formation predict that feedback from supernovae plays a crucial role in regulating star formation in low-mass galaxies. Efficient feedback, with large outflow rates, is needed in these models to account for the low-efficiency of galaxy formation in low-mass halos. Current constraints on mass outflow rates in this low mass regime are very sparse and the best estimates are uncertain by orders of magnitude. In order to test feedback models, we selected a unique sample of z=1 star-forming galaxies, near background quasars, that show direct evidence of strong outflows: they show large velocities (200-500 km/s) from the low-ionization absorption lines. The advantage in using background quasars over traditional galaxy spectra is that the kinematics and location of the cool gas can be determined accurately. The one missing ingredient in order to determine accurate mass outflow rates is the total gas column density. Therefore, we propose to measure the total gas column density and empirically determine the ouflow rates in low-mass (sub-L*) star-forming galaxies using COS/G230L given the redshift of our sources. With these data we will answer the fundamental question: Are the mass outflow rates higher than the star-formation rates as predicted by theory? Our sample is unique: for each quasar-galaxy pair, ?we have deep IFU kinematics of the galaxy and the line-of-sight kinematics with high-resolution? optical spectroscopy. Our results will be a huge step forward and provide a strong bench mark for models.
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Proposal Category: GO
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12523
Title: Dissecting the integrated light of a massive elliptical galaxy with pixel-to-pixel fluctuations: is the IMF bottom-heavy?
PI: Charlie Conroy
PI Institution: Harvard University

The stellar initial mass function (IMF) is a critical ingredient in the interpretation of extragalactic observations and provides important clues to the physics of star formation. Unfortunately, the low-mass IMF (M<0.3 Msun) is very difficult to measure beyond the Galaxy because low mass dwarf stars contribute only a few percent to the integrated light of old stellar populations. Using high quality Keck spectra we recently found that massive elliptical galaxies in the Virgo and Coma clusters have enhanced dwarf-sensitive absorption features, indicating a very "bottom-heavy" IMF with many more low-mass stars than the IMF in our Galaxy. The main uncertainty in this result is that the subtle absorption features that we ascribe to dwarf stars may actually be due to unusual abundance patterns in giant stars. Here we propose to directly determine whether three key IMF sensitive spectral features in massive elliptical galaxies are caused by giants or by dwarfs. We will exploit the high angular resolution of ACS, in combination with its unique ramp filters, to measure pixel-to-pixel fluctuations in the light of these spectral features for one of the massive Virgo elliptical galaxies that we previously observed with Keck (NGC 4649). Pixel-to-pixel fluctuations are caused by Poisson variations in the number of giants, and by correlating the behavior of a spectral feature with the number of giants in each pixel we

directly measure whether that feature comes from giants or dwarfs.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12524
Title: Enabling High-z Discoveries Through UV Spectroscopy of Low-Redshift Super-Luminous Supernovae
PI: Robert Quimby
PI Institution: California Institute of Technology

A new class of stellar outbursts dwarfing the most powerful supernovae observed in the past century has recently been uncovered by wide field optical imaging surveys. With peak luminosities in excess of 10^44 erg/s and total radiative outputs greater than 10^51 erg, these events push the limits of conventional supernova explosion theory. A few of these events have now been monitored by Swift, and these observations reveal high-UV luminosities as well. These super-luminous supernovae (SLSNe) are thus of great potential interest for probing the high redshift universe, but current constraints on their (time-variable) UV spectral energy distributions are weak. This leads to significant uncertainties as to the observational signatures of high-redshift SLSNe in optical or IR studies. To address this, we propose a ToO program for NUV spectroscopy to follow-up new SLSNe discoveries in Cycle 19 supplemented with Swift UV photometry and ground based optical imaging and spectroscopy from the Keck and Palomar observatories.
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Proposal Category: GO
Scientific Category: AGN/QUASARS
ID: 12525
Title: Giant Ionized Clouds Around Local AGN - Obscuration and History
PI: William Keel
PI Institution: University of Alabama

We propose emission-line and continuum imaging of a set of giant ionized clouds around nearby AGN, most newly identified by the Galaxy Zoo project. These are selected to be most likely to show fading of the AGN over times <100,000 years, based on energy balance arguments. The images can show signatures of fading based on recombination timescales, and evidence of additional outflow from the AGN shown in triggered star formation and morphology of gas features. These objects are smaller counterparts of the giant nebulosity Hanny's Voorwerp, where the AGN must have faded by 1000x within 200,000 years, and could help shed light on hitherto inaccessible timescales in AGN. In particular, results on Hanny's Voorwerp lead us to speculate that the fading has been accompanied by increased kinetic energy output ("mode switching"), which we can likewise seek in these less energetic counterparts.
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Proposal Category: GO
Scientific Category: AGN/QUASARS
ID: 12526
Title: Mapping Recent Star Formation and Dust in NGC 1266, a Local Example of AGN-driven Feedback
PI: Katherine Alatalo
PI Institution: University of California - Berkeley

NGC 1266 is a nearby lenticular galaxy with a unique property: it hosts a massive outflow of molecular gas. This outflow appears to be driven by an AGN. AGN feedback may play an important role in galaxy evolution, particularly as a star formation quenching mechanism, but the details are not well understood. At only 30 Mpc away, NGC 1266 presents the best local laboratory for studying the AGN feedback process in action. A large multi-wavelength data set already exists, including high resolution X-ray imaging and radio observations, as well as resolved stellar kinematics from integral field unit data. The existing ground-based optical imaging shows hints of a dust cone along the direction of the outflow, and possibly indications of a recent minor merger, which may have triggered the current outflow and AGN activity. However, the images are of modest resolution, significantly worse than the resolution necessary to provide information about the star formation history and dust distribution associated with the outflow. This proposal aims to acquire high resolution optical, near-infrared, and NUV imaging using ACS/WFC, WFC3/IR, and WFC3/UVIS. The primary goals are to resolve the sites of recent star formation, create multi-stellar population models on the same scale as the molecular gas features (> 1"), to map the detailed dust morphology and properties, and to further constrain the total mass of outflowing material.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12527
Title: Resolving Lyman Continuum Emission from Lya-Emitters
PI: Brian Siana
PI Institution: California Institute of Technology

Escaping Lyman-continuum (LyC) radiation from star-forming galaxies is likely responsible for the reionization of the universe. The direct measurement of escaping LyC radiation has proven exceptionally challenging. Using deep, ground-based, near-UV imaging, we have obtained direct LyC detections of both Lyman Break Galaxies (LBGs) and Lyman-Alpha Emitters (LAEs) at z=3.1. These observations have revealed high values for the escape fraction of LyC photons, based on the observed ratio of ionizing to non-ionizing UV radiation. In particular, the LyC escape fractions for some LAEs challenge models of stellar populations. While representing progress, the interpretation of these detections is ambiguous due to the seeing-limited resolution. Our Cycle 17 WFC3/UVIS program mapping the LyC emission for a pilot sample of 6 objects (3 LBGs, 3 LAEs) has revealed a diversity of mechanisms for the escape of ionizing radiation, and highlighted the need for a larger sample of resolved LyC observations. With two additional WFC3/UVIS+F336W pointings, we will target 9 faint z=3.1 LAEs and 2 LBGs - all spectroscopically confirmed at z~3.1 and all with LyC detections in ground-based data. Our observations will quadruple the sample of LAEs with resolved LyC observations, and almost double the sample of LBGs. Based on an efficient observing strategy, we require 24 orbits of WFC3/UVIS+F336W imaging of ionizing radiation and 3 orbits of ACS+F814W imaging of the non-ionizing UV continuum. With these deep, high-resolution maps of ionizing and non-ionizing UV radiation, we will constrain the mechanisms responsible for large escape fractions, and gain insight into the process of reionization.
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Proposal Category: GO
Scientific Category: HOT STARS

ID: 12528
Title: Probing the Nature of LBVs in M31 and M33: Blasts from the Past
PI: Philip Massey
PI Institution: Lowell Observatory

Luminous Blue Variables (LBVs) are a short-lived, but critical stage in the evolution of the most massive stars. Episodic outbursts during the LBV phase may provide the dominant mass-loss mechanism for evolution to the Wolf-Rayet stage. However, these large mass-loss outbursts (accompanied by large changes in the visual magnitude) take place on timescales of order 1000 years or so: the archetypical LBVs P Cyg and Eta Car had their last major outbursts in the 17th and 19th centuries, respectively. Were these stars located in nearby galaxies would we know of them today? Only six LBVs have been confirmed in M31 and M33 through detection of outbursts, although 175 stars have now been identified as LBV "candidates" in these galaxies. These LBV candidates are spectroscopically indistinguishable from the known LBVs, but no large-scale (>2 mag) photometric outbursts have been found, although many of the candidates do show smaller photometric variability and/or spectroscopic variability. Rather than wait 1000 years for an outburst, we instead here propose to look for signatures of past outbursts in the form of ejecta nebulae close to the stars. The high spatial resolution of STIS will be sensitive to nebulae with radii larger than 0.3-0.4 pc, which corresponds to ages of >500-1000 yrs. These data will allow us to determine the frequency of ejecta among our LBV candidates compared to those of the known LBVs, and determine the physical characteristics of these past mass-loss events. Ultimately, this will help us constrain the lifetime and total mass lost in the LBV phase.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12529
Title: What Powers Nature's Most Luminous Supernovae?
PI: Alicia Soderberg
PI Institution: Harvard University

Thanks to the recent advent of wide-field transient surveys, supernovae with extreme peak luminosities, M < -22 mag, are being revealed at alarming rates. The origin of these events is hotly debated and popular ideas range from pair instability supernovae to central engine driven explosions. The Pan-STARRS survey, now in full operation, provides an unprecedented opportunity to discovery and study this new class of ultra-luminous at typical redshifts of z~1. Here we propose (non-disruptive) HST Target-of-Opportunity observations of nature's most luminous supernovae to crack the mystery of what powers these beasts.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12530
Title: Early-Time UV Spectroscopy of a Stripped-Envelope Supernova: A New Window
PI: Alex Filippenko
PI Institution: University of California - Berkeley

We propose to obtain 5 epochs of UV spectroscopy of a Target of Opportunity stripped-envelope core-collapse supernova during 2 weeks roughly centered on

maximum brightness. The underlying nature of these objects, from the mechanism by which they lose their envelopes to the details of their explosions, remains mysterious. Their connection to gamma-ray bursts and X-ray flashes only increases the importance of understanding these mechanisms. In addition, many supernovae of all types will be found in future high-redshift transient surveys, but the ability to distinguish between Type Ia (thermonuclear) supernovae and stripped-envelope supernovae will require a more thorough knowledge of the latter, especially at UV wavelengths. The spectra we propose to obtain will lead to several new insights. By comparing the evolution of the spectra as the photosphere recedes to deeper layers of the ejecta to our time series of spectral models, we will gain a better understanding of the explosion and possibly the progenitor star. Specifically, we may be able to determine the metal content of the progenitor through comparisons with our spectral models, and we should be able to probe the degree of mixing during the explosion. With coordinated observations of the SN in the optical and near-IR using our ground-based programs, we will be able to accurately characterize the nature of the emission radiated by these supernovae.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12531
Title: Tracking the Continuing Evolution of SN 1993J with COS and WFC3
PI: Alex Filippenko
PI Institution: University of California - Berkeley

SN 1993J is the best-studied supernova (SN) in terms of circumstellar interaction, and it is the second-nearest SN in modern times. Its progenitor lost most of its H envelope in binary Roche-lobe overflow prior to exploding as a Type IIb SN, so it enables us to investigate a different type of SN and progenitor star than SN 1987A. It is now making a transition into the SN remnant phase, where X-rays from the SN shock propagate inward to illuminate the processed ejecta. Our HST observations up to year 2000 gave conclusive evidence for CNO processing in the outer envelope of the SN. Optical observations with Keck now show a critical transition from a hydrogen-dominated to an oxygen-dominated spectrum, as deeper layers of the stellar interior are exposed and illuminated. We propose to complement these optical observations with FUV and NUV spectra, which trace important ionization levels of several lines of carbon, nitrogen, oxygen, and silicon that cannot be observed in optical spectra, but are essential for accurate abundances. These data will provide a quantitative estimate of the nucleosynthetic products in the ejecta near the core. Moreover, the widths of emission lines will allow us to follow the interaction of the ejecta with the circumstellar gas, as the SN turns into a SN remnant. In addition, we propose imaging in the UV, optical, and near-IR for characterizing the SN environment, in particular the properties of the putative companion star from the original binary system; we will also use these data to eliminate continuum contamination in the spectra. We will also make coordinated multiwavelength observations and conduct detailed spectral modeling.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12532
Title: The Scale Sizes of Globular Clusters: Tidal Limits, Evolution, and the Outer Halo

PI: William Harris
PI Institution: McMaster University

The physical factors that determine the linear sizes of massive star clusters are not well understood. Their scale sizes were long thought to be governed by the tidal field of the parent galaxy, but major questions are now emerging. Globular clusters, for example, have mean sizes nearly independent of location in the halo. Paradoxically, the recently discovered "anomalous extended clusters" in M31 and elsewhere have scale sizes that fit much better with tidal theory, but they are puzzlingly rare. Lastly, the persistent size difference between metal-poor and metal-rich clusters still lacks a quantitative explanation. Many aspects of these observations call for better modelling of dynamical evolution in the outskirts of clusters, and also their conditions of formation including the early rapid mass loss phase of protoclusters. A new set of accurate measurements of scale sizes and structural parameters, for a large and homogeneous set of globular clusters, would represent a major advance in this subject. We propose to carry out a (WFC3+ACS) imaging survey of the globular clusters in the supergiant Virgo elliptical M87 to cover the complete run of the halo. M87 is an optimum target system because of its huge numbers of clusters and HST's ability to resolve the cluster profiles accurately. We will derive cluster effective radii, central concentrations, luminosities, and colors for more than 4000 clusters using PSF-convolved King-model profile fitting. In parallel, we are developing theoretical tools to model the expected distribution of cluster sizes versus galactocentric distance as functions of cluster mass, concentration, and orbital anisotropy.
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Proposal Category: GO
Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12533
Title: Escape of Lyman-Alpha Photons from Dusty Starbursts
PI: Crystal Martin
PI Institution: University of California - Santa Barbara

We request COS spectroscopy of sixteen, well-studied Ultraluminous Infrared Galaxies (ULIRGs). Dusty starbursts similar to these galaxies made a very significant contribution to the global star formation rate in the past. Since dust destroys hydrogen Lyman-alpha photons, it came as a great surprise when optical spectroscopy of dusty, high-redshift galaxies revealed hydrogen Lyman-alpha (LyA) emission. Ironically, less is directly known about the LyA emission properties of dusty galaxies nearby; but only in nearby galaxies like ULIRGs can the physical properties -- gas kinematics and dust content -- that determine the LyA escape fraction be examined in detail. Studying LyA radiative transfer in the local laboratories afforded by nearby ULIRGs is therefore critical to improving our understanding of LyA radiative transfer in dusty galaxies. This local calibration is critical because the LyA emission properties of galaxies provide much of our information about galaxy evolution at the highest redshifts.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12534
Title: The Panchromatic Hubble Ultra Deep Field: Ultraviolet Coverage
PI: Harry Teplitz

PI Institution: California Institute of Technology

The Hubble UltraDeep Field (UDF) has deep observations at Far-UV, optical (B-z), and NIR wavelengths, but only comparatively shallow near-UV (u-band) imaging from WFPC2. We propose to fill this gap in UDF coverage with deep near-ultraviolet imaging with WFC3-UVIS in F225W, F275W, and F336W. We take advantage of the unique capabilities of HST to reach point source detection limits of AB=29, a factor of ten fainter than the GALEX ultradeep surveys. In the spirit of the UDF, we submit this proposal in the Treasury category. We will increase the legacy value of the UDF by providing science quality images, photometric catalogs, and improved photometric redshifts to enable a wide range of research by the community. The scientific emphasis of this proposal is to investigate the episode of peak star formation activity in galaxies at 1<z<2.5. The UV data will enable identification of galaxies in this epoch via the Lyman break and will allow us to trace the rest-frame FUV luminosity function and the internal color structure of galaxies. We will measure the star formation properties of moderate redshift starburst galaxies including the UV slope. The high spatial resolution of UVIS (a physical scale of about 700 pc at 0.5<z<1.5) will enable an investigation of the evolution of massive galaxies by resolving sub-galactic units (clumps). We will measure (or set strict limits on) the escape fraction of ionizing radiation from galaxies at z~2-3 to better understand how star-forming galaxies reionized the Universe. We will bin the CCD readout (2x2 pixels) in the read-noise limited F225W and F275W filters, providing the same surface brightness sensitivity in 38% of the time.

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Proposal Category: GO
Scientific Category: SOLAR SYSTEM
ID: 12535
Title: Orbital Refinement and Characterization of New Horizons KBO candidates
PI: 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 the Pluto encounter, it is planned that the spacecraft will be retargeted to one or more yet-to-be-discovered Kuiper Belt Objects (KBOs) to learn about small KBOs and the Kuiper Belt debris body population. We are actively carrying out dedicated ground-based observations in 2011 and 2012 using large class telescopes to discover a KBO target that will be within the trajectory cone of NH. Unfortunately, the NH trajectory's line of site is within the galactic plane (Sagittarius) making stellar confusion a major problem in detecting and tracking KBOs in this region. HST’s sensitivity, resolution and PSF stability are a significant advantage in these confusion-limited starfields. We are requesting TOO orbits for up to 3 KBOs (2 orbits per KBO) to be triggered in the event that a candidate object is found in the NH trajectory. Objects must be recovered at multiple epochs to determine if their orbits will continue to place the object within the NH trajectory in the future. The observations we propose will also determine if the candidate is binary (~30% probability per candidate) and make a preliminary color determination.

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Proposal Category: GO
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12536

Title: Sub-damped Lyman-alpha Absorbers at z < 0.6: An Unexplored Terrain in the Quest for Cosmic Metals
PI: Varsha Kulkarni
PI Institution: University of South Carolina Research Foundation

The metal content of galaxies offers a unique tracer of star formation and galaxy evolution processes. Damped and sub-damped Lyman-alpha absorbers constitute the primary neutral gas reservoir for star formation and provide the most accurate element abundances in distant galaxies. Contrary to model predictions, DLAs appear to be metal-poor at all redshifts, with relatively little metallicity evolution. Surprisingly, we have recently discovered several near-solar or supersolar sub-DLAs at 0.6 < z < 1.5, suggesting that sub-DLAs may contribute much more than DLAs to the cosmic metal budget at these redshifts. However the sub-DLA samples are small, with no sub-DLA metallicity data at 0.01 < z < 0.6 (~40% of the age of the universe). Furthermore, the effect of ionization corrections on sub-DLA metallicities needs to be investigated. Here we propose COS spectroscopy of 5 sub-DLAs at z < 0.6 to measure absorption lines of S II, S III, Si II, Si III, Fe II, Fe III, etc. Our data will yield the first sub-DLA metallicities at low z, clarify the role of ionization in these systems, and help explore the velocity-metallicity correlations in sub-DLAs. Our data will shed light on where sub-DLAs and DLAs fit in the overall picture of galaxy evolution.
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Proposal Category: GO
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12537
Title: Venus observed as an extrasolar planet
PI: Alfred Vidal-Madjar
PI Institution: CNRS, Institut d'Astrophysique de Paris

In a relatively near future, numerous transiting extrasolar planets will be discovered (gaseous giant planets, Earth-size planets and temperate Uranus in the form of "Ocean-planets"). Space telescopes operating in the UV-optical-IR will allow the study of their atmospheres. We have to show if and how these observations will give access to the detection of atmospheric species, particularly when telluric planets will be observed, to demonstrate that life may be possible on one of them. For that purpose, we propose to use the unique event of the century, the Venus transit in 2012 (next Venus transits are in 2117 and 2125
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Proposal Category: GO
Scientific Category: SOLAR SYSTEM
ID: 12538
Title: Detection of Hot (Escaping?) Hydrogen in the Martian Atmosphere
PI: John Clarke
PI Institution: Boston University

This proposal is to make STIS spectroscopic observations of the H Ly alpha emission line profile from Mars to determine the fraction of hot hydrogen in the martian corona. Prior ACS/SBC images of the hydrogen corona have shown its large extent, and found it to be more highly variable than previously thought. The variation in the extent of the corona appears to be dependent on the water vapor abundance in the lower atmosphere, which would have profound implications for the escape of water over the history of Mars. The next step

is to isolate the fraction of H atoms in the corona that are superthermal, which can be done using STIS E140H and a long narrow aperture (52x0.2), providing 0.025 nm resolution. These observations are the next step is addressing the escape of hydrogen and water from Mars, and extending the loss rate into the past.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12539
Title: A novel approach to find Lyman continuum leaking galaxies at z~0.3 with COS
PI: Nils Bergvall
PI Institution: Uppsala Astronomical Observatory

What drives the early phase of cosmic reionization is poorly known. Numerous low to intermediate-mass star forming galaxies are the most promising candidates, but the problem is to understand how the ionizing radiation can leak out into the intergalactic medium. Models indeed predict the escape of LyC radiation from dwarf starburst galaxies under certain conditions, but it has proven to be observationally very difficult to confirm this in the local galaxy sample. Except in very few reported cases the envelope of neutral gas seems to halt all Lyman continuum photons. To better understand this discrepancy, we here propose to observe with COS a small sample of local starburst galaxies selected from the SDSS for their very blue colours, young ages and weak H-alpha emission. This combination can, according to models, occur only when a large fraction of the ionizing radiation escapes from the galaxy. The redshifts of our four targets is z~0.3, which puts the LyC in a spectral region where the sensitivity of COS/G130M is high. Since it might be counterintuitive to select strong starbursts by weak H-alpha emission, it can be understood that all earlier searches for LyC emission at low redshifts have had a high rate of failure. Selection techniques utilizing star formation indicators like strong optical emission lines will bias the samples towards galaxies with a high neutral gas-fraction, and thereby against LyC escape. With the novel approach for target selection in this proposal, we are instead sure to optimize the success rate.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12540
Title: UV Studies of a Core Collapse Supernova
PI: Robert Kirshner
PI Institution: Harvard University

The UV spectrum of a core collapse SN encodes unique information about nucleosynthesis, the star's mass loss history, shock physics, and dust formation. This proposal aims at a detailed study of one bright core collapse SN, discoved as a result of the many ongoing surveys, either a Type IIP, IIn or Ib or Ic supernova. We will address the role of circumstellar interaction and mass loss through CNO lines in the UV, the nature of dust formation from UV line profiles, and we will use the UV continuum as a diagnostic of non-thermal emission from the shock. The overall goal is to achieve a better understanding of these objects by combining ground-based observations with complementary HST data. In cycle 17 and cycle 18 we obtained excellent data for SN 2010al and SN 2010jl that live up to our expectations. In the past, we have used HST to obtain critical UV spectra from the explosion to the nebular

phase with good results for a limited number of objects. The advent of COS provides new capability for UV observations which we would like to exploit. When nature provides a bright candidate, HST should be ready to respond.
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Proposal Category: GO
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12541
Title: Measuring the Exoplanet Mass Function Beyond the Snow-Line
PI: David Bennett
PI Institution: University of Notre Dame

The dominant theory for the formation of planets is the core accretion theory, and in this theory, the most massive planets are thought to form beyond the snow line where ices have condensed to maximize the solid material available for the formation of planet cores. There are only 7 known exoplanets with likely masses of less than 50 Earth-masses located beyond the snow line, and all of them been found by gravitational microlensing. Statistical analyses of the early microlensing results indicate that planets with mass ratios in the Neptune-Saturn range are quite common beyond the snow line and that planets with smaller mass ratios are more common. This appears to be in accord with the predictions of the core accretion theory, but precise tests of the theory are hampered by the fact that the mass of only one of these 7 cold, low-mass planets is known. We propose to remedy this difficulty by determining the masses of 4 additional low-mass microlens planets located beyond the snow line to bring the total number of low-mass planets beyond the snow-line to 5. We will apply innovative techniques that rely upon the high angular resolution of HST images and the unique stability of the HST point spread function. The proposed observations will provide individual planet and host star masses and distances for each of the microlensing planetary systems that we observe, and they will allow us to make a first estimate of the exoplanet mass function beyond the snow line. The propose observations will also demonstrate the primary planetary mass measurement method of the WFIRST mission.
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12542
Title: A Multispectral Survey of the Translucent Cloud in front of HD 204827
PI: Theodore Snow
PI Institution: University of Colorado at Boulder

We propose to observe interstellar absorption toward the O V 9 star HD 204827 for 30 orbits in order to make a comprehensive survey of the prototypical translucent molecular cloud that lies in the direction of that star. The high throughput of COS at medium resolution will make it possible to overcome the effects of the extinction at the shorter UV wavelengths while STIS will be used to cover important features at longer wavelengths. These data will enable us to: test and refine chemical models; infer elemental depletions; estimate the density and radiation field intensity (by measuring the ionization balance and molecular excitation); and search for new molecules, including complex organics. We will use a combination of medium-resolution STIS and COS observations, and also a wide variety of ancillary instruments in space (the Spitzer Space Telescope) and on the ground (optical and infrared spectrographs, radio spectrometers, and laboratory spectroscopic

measurements). The result of this program, including the ancillary observations, will be the most complete analysis of any isolated translucent interstellar cloud.
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12543
Title: Fine-scale Density, Temperature, and Ionization Fluctuations: Their Effect on Abundance Determinations
PI: Robert Rubin
PI Institution: NASA Ames Research Center

Knowledge of chemical abundances is fundamental to understanding the processes of nucleosynthesis and galactic chemical evolution. There are two major problems in nebular astrophysics that seriously affect the ability to derive reliable elemental abundances from emission lines. Attempts to solve these long-standing problems [the "abundance" & "temperature problems"-see text] have focused on electron temperature (Te) fluctuations within nebulae. The problems remain, and there is now a substantial faction who argue that Te variations alone are insufficient. We propose to build upon the previous observations of the benchmark Orion Nebula to measure not only Te variations but also the cospatial electron density (Ne) and ionization variations. With the new capability enabled by WFC3 and its unique set of narrow-band filters, we will obtain images with a scale as fine as 0.04". Through these filters, we will isolate emission lines including OIII 4363 & 5007, NII 5755 & 6584, SII 6716 & 6731, and SIII 9532 A. These observations will allow us to study in unprecedented detail variations (as well as their interdependence) in the fine-scale structure of Ne[SII], temperature (Te[OIII] for the high-ionization regions, Te[NII] for the low-ionization ones), and the degree of ionization via S+/S++. As a coordinated parallel program with no added time, we will image with ACS/F658N to provide a second epoch dataset with at least a seven year time-base. The goal is to obtain greater accuracy for the motions of jets and shocks arising from Young Stellar Objects and thus to better determine the time-dependent-characteristics of the episodic collimated outflows from these objects.
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Proposal Category: GO
Scientific Category: COOL STARS
ID: 12544
Title: Confirming Ultra-cold (Teff < 500K) Brown Dwarf Suspects Identified with WISE
PI: Michael Cushing
PI Institution: Jet Propulsion Laboratory

Despite the spectacular success of wide-field, sky surveys (2MASS, SDSS, and UKIDSS) in uncovering a large population of brown dwarfs in the solar neighborhood, a gap of nearly 400 K remains between the coolest brown dwarfs known (Teff ~ 500 K) and Jupiter (Teff ~ 128 K). Yet it is exactly these cold, low-mass brown dwarfs that are essential to measuring the functional form of the low-mass mass function and determining the lower mass limit of star formation. With atmospheric conditions similar to those of giant planets, cold brown dwarfs are also excellent proxies with which to test the ultracool model atmospheres that are critical to our understanding of exoplanets. One of the primary science goals of the Wide-field Infrared Survey Explorer (WISE), a NASA mission that recently completed a survey of the

entire sky at four mid-infrared wavelengths, is to discover a large population of these cool brown dwarfs. As part of a larger followup campaign that involves both ground- and space-based observatories, we were awarded 12 orbits in Cycle 18 (as part of a Cycle 7 Spitzer program) to obtain near-infrared WFC3 grism spectroscopy of twelve of our faintest and reddest, and thus presumably coldest, brown dwarf candidates. We here propose to obtain spectra of an additional four objects that, along with the twelve Cycle 18 targets, constitute the best cold brown dwarf candidates that we have identified in roughly half of the sky. These objects are too faint for spectroscopic verification from the ground so HST/WFC3 observations are the only avenue for confirming their ultracool nature.

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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12545
Title: Dust Destruction in the ISM: The Cygnus Loop Blast Wave
PI: John Raymond
PI Institution: Smithsonian Institution Astrophysical Observatory

Interstellar dust is destroyed in supernova remnant shocks, but the destruction rate is poorly known. Model-dependent constraints can be obtained from IR observations with Spitzer and from X-ray images, since liberation of volatiles from grains increases the X-ray emissivity. We propose to obtain a more direct, model independent measurement by using COS to observe emission in the C IV lines from carbon sputtered from grains as it is ionized toward equilibrium at X-ray emitting temperatures. We have chosen a shock wave in the Cygnus Loop where we have dust parameters from Spitzer, the electron temperature from Chandra, and shock speed and density from optical and FUSE spectra. The dust destruction zone is spatially resolved, and we have developed models for the evolution of Spitzer and Chandra spectra as grains are destroyed and refractory elements are returned to the gas phase. The UV sensitivity of COS makes this observation possible.

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Proposal Category: SNAP
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12546
Title: The Geometry and Kinematics of the Local Volume
PI: 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.

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Proposal Category: GO
Scientific Category: STAR FORMATION
ID: 12547
Title: Measuring the Star-Formation Efficiency of Galaxies at z > 1 with Sizes and SFRs from HST Grism Spectroscopy
PI: Michael Cooper
PI Institution: University of California - Irvine

For a sample of 13 star-forming galaxies at 1 < z < 1.4, selected from an ongoing IRAM/PdBI CO survey that measures molecular gas masses, we propose HST/WFC3-IR G141 grism spectroscopy to measure Halpha fluxes and sizes. The spatial resolution of HST combined with the sensitivity of Halpha as a star-formation indicator afford the ability to precisely trace the current amount and extent of star formation in galaxies at z > 1, physical properties that are poorly constrained with ground-based or Spitzer IR observations. Together, the HST and radio data will create the first sample of relatively typical star-forming galaxies at high redshift that have measurements of both molecular gas and star formation rate (SFR) surface densities. Combined with existing HST grism observations of 3 additional galaxies from our CO survey (for a total of 16 sources), this dataset will provide unprecedented insight into what fueled the high level of global star formation at z > 1 and what drove its decline over the last 7 Gyr. The precise measurements of current SFR and its spatial extent, derived from WFC3 spectroscopy, will enable us to determine if the higher SFRs at high redshift are due to greater supplies of cold gas or greater star formation efficiencies. Furthermore, the proposed observations will allow us to test the applicability of the Kennicutt-Schmidt relation for star formation rate versus gas surface density at high redshift, where the bulk of star formation occurs. This relation, which is a critical component of galaxy formation models, remains poorly constrained beyond the local Universe.

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Proposal Category: GO
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12548
Title: Constraining Planet Formation in the Unique Evolved Binary HR 637 (GJ 86)
PI: Jay Farihi
PI Institution: University of Leicester

An intriguing characteristic of the known exoplanets is the existence of gas giants in moderately close binary systems. Among these planet-hosting binaries, the HR 637 (GJ 86) system is particularly interesting; the exoplanet GJ 86b executes a 0.1 AU orbit about an early K dwarf that is in turn bound to a white dwarf near 20 AU. The progenitor of GJ 86B was originally the more massive stellar component, orbiting near 12 AU until post-main sequence mass loss expanded its separation. This picture presents a gravitational challenge to planet formation at GJ86A: how does a giant planet form around a solar-mass star in such close proximity to an intermediate-mass star? Also, did GJ 86b form at the same epoch as the stars, or during the post-main sequence

evolution of the secondary? To model the formation of GJ 86b, a knowledge of the current and primordial stellar masses and separations is required. We propose WFC3 imaging of this high-contrast, 2 arcsec binary in several bandpasses, and subsequent STIS optical spectroscopy of the white dwarf GJ 86B. The imaging is essential to determine the precise location of the companion for STIS spectroscopy, while the broad-band colors will yield the temperature of the white dwarf. The spectroscopy will reveal the atmospheric composition -- including refractory pollutants -- of the white dwarf, and together with its known parallax, determine its radius and mass, the mass of its progenitor, the original binary separation, and total system age. From these data, we will be able to strongly constrain planet formation scenarios in this relatively close binary, and potentially obtain evidence of terrestrial planets within the system.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12549
Title: The Formation History of the Ultra-Faint Dwarf Galaxies
PI: Thomas Brown
PI Institution: Space Telescope Science Institute

We propose a deep, high-precision, photometric survey of six ultra-faint dwarf galaxy satellites of the Milky Way, in order to discern any cosmologically-driven synchronization of their formation histories. This new class of galaxy, recently discovered in the Sloan Digital Sky Survey, appears to be an extension of the classical dwarf spheroidals to low luminosities, offering a new front in the efforts to understand the missing satellite problem. Because they are the least luminous, most dark matter dominated, and least chemically evolved galaxies known, the ultra-faint dwarfs are the best candidate fossils from the early universe. While the classical dwarfs are chemically distinct from the progenitors of the Milky Way halo, the ultra-faint dwarfs appear to be representative of the galaxies that populated the metal-poor tail of the halo. Hierarchical models of galaxy formation under Lambda CDM predict that the ultra-faint dwarfs formed the bulk of their stars before the epoch of reionization. Relying upon relative age measurements with sub-Gyr resolution, we will characterize the age dispersion within each galaxy, the age variation among these galaxies, and the ages of these galaxies relative to those of the Galactic globular clusters. These measurements will provide the only meaningful test of the synchronized star formation predicted by current models. The program will be an important test of our current assumptions regarding the hierarchical assembly of galaxies at the low-mass end of the power spectrum, and place this new class of galaxy in a cosmological context.
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Proposal Category: SNAP
Scientific Category: COOL STARS
ID: 12550
Title: Physics and Chemistry of Condensate Clouds across the L/T Transition - A SNAP Spectral Mapping Survey
PI: Daniel Apai
PI Institution: University of Arizona

Condensation, cloud formation and dissipation play a fundamental, yet poorly understood role in shaping the spectra of extrasolar giant planets and ultracool brown dwarfs. Clouds can suppress the emission of substellar objects and thus slow their, altering their evolution and leading to larger radii for

a given age. Clouds are also thought to play a key role in the dramatic but yet unexplained L/T spectral type transition. Diverse models have been proposed to explain the atmospheric evolution, from multi-condensate clouds to growing holes and sudden collapse of the cloud layers with decreasing temperatures. These models, however, are only weakly constrained by present-day observations. We propose to address this challenge by using the unparalleled sensitivity and stability of WFC3 to obtain time series of G141 grism spectra of up to 60 single L/T dwarfs in a SNAP survey. With typical rotation periods of 3 hours our single-orbit observations will sample 1/3 to 1/4 of the surface of the targets. We will measure the level of rotational variability as a function of spectral type and wavelength to determine the frequency of clouds of different compositions. These observations will answer the questions: Are patchy clouds responsible for the L/T transition? and, What is the physical structure and chemical composition of the clouds (or hotspots) across the photospheres of the targets? Our observations will provide the first reliable study of the rate of spectroscopic variability — and thus chemical diversity — of ultracool atmospheres and identify exciting sources for in-depth follow-up.

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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12551
Title: Imaging Disk-Planet Interactions in the Beta Pictoris Disk
PI: Daniel Apai
PI Institution: University of Arizona

Debris disks are readily detectable tracers of the embedded planetary systems, but we do not always know how to interpret them. Models of disk-planet interactions remain untested as most directly imaged debris disks do not harbor known exoplanets. The prototypical debris disk around Beta Pic and its newly discovered relatively short-period super-jupiter planet offer a unique laboratory for studying disk–planet interactions. Models identified more than five mechanisms through which Beta Pic b may shape the complex disk structure and may perturb planetesimals to an inclined orbit, giving rise to the secondary disk discovered with HST. Structures shaped by the planet's resonances can introduce prominent azimuthal asymmetries in the disk that orbit on timescales similar to that of the planet (~18 yr). With STIS images from 1997 a uniquely long baseline is available for identifying the temporal evolution of the disk. We propose to revisit and monitor the Beta Pic disk with STIS to characterize the temporal evolution of the disk. By repeating earlier STIS observations we will detect variations as small as 2-3% at 0.7”. In comparison, models of radiation-pressure driven small grains freed from planetesimals trapped in resonance with the planet predict variations up 300% in this component. By monitoring Beta Pic we will identify disk structures and dust grain populations that trace the directly imaged planet, directly testing models explaining the Beta Pic disk’s complex structure. These observations will provide an entirely new set of constraints on the 3D structure and dynamics of the best-studied debris disk — the only disk/planet system where such measurements are possible.

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Proposal Category: GO
Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12552
Title: Shock Energy in Merging Systems: The Elephant in the

Room.
PI: Lisa Kewley
PI Institution: University of Hawaii

The relationship between shocks, star formation and the evolution of merging galaxies is not well understood. We are now poised to gain major insight in this area, thanks to the high resolution narrow-band imaging capabilities of WFC3 and recent major advances in theoretical shock and and photoionization models. Shocks and star formation in merging galaxies are regulated by fundamental physical properties of the ISM such as dust, gas density, ionized gas structure, and the presence of galactic winds and outflows. We aim to uncover the relationship between shocks, galactic winds, and the fundamental ISM properties in two famous mergers NGC 6240 and Arp 220. These two galaxies are currently transitioning from disk galaxies into spheroids and they are close enough to achieve the spatial scales required to resolve individual supernova remnants with WFC3 imaging. We propose to image NGC 6240 and Arp 220 in key shock and photoionization sensitive diagnostic lines [OII], [OIII], H-beta, [NII]+H-alpha, [SII], and (where possible) [OI] to (1) resolve the source of the ionizing radiation field (shocks versus photoionization by hot stars) at spatial scales of 25-35 pc, and (2) map the distribution of the star formation and ionized gas to search for links with merger-driven shocks and large-scale gas flows.
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Proposal Category: GO
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12553
Title: Detecting the stellar continuum of the galaxy counterparts of three z>2 Damped Lyman-alpha Absorbers
PI: Johan Fynbo
PI Institution: University of Copenhagen, Niels Bohr Institute

Despite more than 20 years of study the Damped Lyman-alpha Absorbers (DLAs) have not yet found their place in the puzzle of galaxy formation and evolution. In particular, the nature of the DLA galaxy counterparts remain very poorly constrained even after substantial amounts of observing time both with HST and 8-m class telescopes. The reason for this is now understood: DLAs are due to their HI cross-section selection drawn from the faint end of the luminosity function. However, we have found evidence that DLAs fullfil luminosity-metallicity and mass-metallicity relations similar to local relations. We have therefore initiated a survey of the galaxy counterparts of metal rich Damped Lyman-alpha Absorbers at redshifts around 2.5 using the newly commissioned X-shooter spectrograph at the ESO Very Large Telescope. For the first 6 targets in the survey we have detected Lyman-alpha, [OIII] and/or H-alpha emission from three of the DLA absorbers. We here proposed to characterize the stellar content of the galaxy counterparts (age, extinction, morphology) and compare these properties with similar properties of emission selected galaxies at similar redshifts. This will be an important step in finding the proper place for DLAs in the puzzle of galaxy formation.
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Proposal Category: GO
Scientific Category: COOL STARS
ID: 12554
Title: The Origins of Carbon-Enhanced Metal-Poor Stars
PI: Timothy Beers
PI Institution: Michigan State University

We propose to measure abundances of light and heavy neutron-capture elements for six of the brightest examples of carbon-enhanced metal-poor (CEMP) stars, in order to provide the data needed to directly test models for the origin of these stars in the early Galaxy. CEMP stars are recognized as important tracers of Galactic chemical evolution at metallicities [Fe/H] < -2.0, where they account for on the order of 20% of all stars, rising to 40% below [Fe/H] = -3.5, and 100% below [Fe/H] = -4.0. Detailed understanding of their astrophysical origin has been limited by the lack of a complete inventory of their neutron-capture elements, which are required to probe the nucleosynthetic processes involved in producing their distinctive abundance patterns. Our targets span the known range of neutron-capture element variations associated with CEMP stars (3 stars with pure s-process enhancements, 2 stars with evidence of both r-process and s-process enhancements, and 1 star with low abundances of neutron-capture elements). Each class may well be associated with different progenitor objects, including the first AGB stars in the Galaxy, "faint supernovae'' undergoing mixing and fallback, or even the winds from massive, rapidly rotating stars with [Fe/H] < -6.0. A more complete set of neutron-capture elements will provide tight constraints on these nucleosynthetic and evolutionary models, including the necessary ingredients for understanding the structure and evolution of the first AGB stars in the Galaxy, and shed light on the transition phase from SNII as major C-producers in the early Universe to AGB stars being the major C-producers at later times.
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Proposal Category: GO
Scientific Category: AGN/QUASARS
ID: 12555
Title: On the Triggering of Quasars During First Passage
PI: Robert da Silva
PI Institution: University of California - Santa Cruz

Merger induced quasar (QSO) activity is commonly invoked as a principal mechanism responsible for the growth of central super-massive black holes (SMBHs) and concurrent evolution of their host galaxies. Despite the apparent successes of such models in reproducing global populations and distributions, fundamental questions surrounding the fueling of SMBHs remain untested. In particular, theoretical treatments predict that the the evolution of the BHs during a merger is determined by their host galaxy's bulge component. We will test this observationally by imaging 10 early-stage merging pairs of galaxies where one galaxy is in a quasar phase and the other is not. By selecting a sample of merging galaxies after first close passage but before final coalescence, we may study the early stages of the merger and precisely determine the properties of the progenitors. This allows a unique 1-to-1 comparison of the QSO-host and companion galaxy that cannot be attained with any other sample. In this manner, we will establish whether quasar triggering is sensitive to the host galaxy morphology. Analysis of the morphologies and stellar masses will also equip us to tackle other key questions related to quasar evolution and triggering. The proposed imaging will constrain the stellar masses of each galaxy to characterize the merger mass ratios that trigger QSO activity. Lastly, comparisons of the SMBH to the host bulge mass, at this intermediate stage, will offer new insights into the path SMBHs take on their way to the Magorrian relation.
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Proposal Category: GO

Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12556
Title: Investigating the Enigmatic Ultraviolet 2175 A Extinction Feature and Correlation with Infrared Aromatic/PAH emission in M101
PI: Karl Gordon
PI Institution: Space Telescope Science Institute

The 2175 Angstrom ultraviolet dust extinction feature has been known for more than 45 years, but the source of the extinction has yet to be positively identified. One of the leading contenders in dust grain models is small aromatic/PAHs grains. Through IR observations of HII regions in the spiral galaxy M101, PAHs have measured emission strengths that dramatically weaken at large radii and ionizations. The parameter space of these HII regions in terms of metallicity, ionization, and PAH emission strengths is the largest of any known galaxy. To explore the connection between the 2175 A extinction feature and IR aromatic/PAH emission strengths, we propose to observe the six regions in M101 (5 HII and the nucleus) using near-UV and far-UV gratings (G230L/G140L) with the MAMA detectors on STIS. The STIS instrument provides the opportunity to obtain high S/N UV spectra integrated over the same large spatial scales of the previous IR observations (~78 square arcsec) in minimal time (2 orbits per region). From the measured spectra, we will employ stellar evolutionary synthesis and radiative transfer models to extract the intrinsic strength of the 2175 A extinction feature. The 2175 A features strengths will be compared with the published emission strengths of five different aromatic/PAH features in all six regions. If the 2175 A feature is associated with aromatic/PAHs grains, we will see a strong correlation. The lack of a strong correlation will imply the need for significant modification of leading dust models.
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Proposal Category: GO
Scientific Category: AGN/QUASARS
ID: 12557
Title: Low-Mass Black Holes and CIV in Low-Luminosity AGN
PI: Kayhan Gultekin
PI Institution: University of Michigan

The observed tight correlations between black hole mass and host galaxy properties evince a fundamental connection between their joint evolution. The key to understanding this co-evolution rests on the ability to measure the smallest black hole masses, which closely trace the formation of black holes. But, recent observational evidence suggests the smallest black holes and/or the smallest galaxies (especially pseudobulges) diverge from the scaling relations. There is therefore a pressing need: (1) to firmly establish multiple, independent measures of black hole mass in these smallest objects, and (2) to accurately determine properties of the host galaxy. Unfortunately, low AGN luminosity means that galaxy contamination is a prohibiting issue for normal ground-based measures of BH mass. But, in the UV this is not a problem allowing the use of CIV to measure BH masses through COS spectroscopy. Moreover, with WFC3 imaging we can unambiguously determine the bulge morphology and luminosity. Therefore, only with our proposed HST campaign to study 6 low-luminosity AGN will we be able to test whether or not the smallest black holes in the smallest galaxies are truly aberrations compared to their higher-mass counterparts.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12558
Title: Identifying and studying gamma-ray bursts at very high redshifts
PI: 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 host ISM and the IGM close to the burst. Thus GRBs offer a unique probe of early star formation and the galaxy populations in the era of reionization. Our efforts to identify high-z GRBs were rewarded with the discovery of GRB 090423 at redshift 8.2. 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 it is likely for others the Ly-alpha break falls 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 can not be secured from the ground. We also propose to monitor the afterglow of one z>7 GRB found, to allow comparison with the lower redshift population of bursts, and to perform an initial search for its host.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12559
Title: Stellar Forensics III: A post-explosion view of the progenitors of core-collapse supernovae
PI: Justyn Maund
PI Institution: University of Copenhagen, Niels Bohr Institute

Recent studies have used high spatial resolution HST observations of supernova (SN) sites to directly identify the progenitors of core-collapse SNe on pre-explosion images. These studies have set constraints about the nature of massive stars and their evolution just prior to their explosion as SNe. Now, at late-times when the SNe have faded sufficiently, it is possible to return to the sites of these core-collapse SNe to search for clues about the nature of their progenitors. We request time to conduct deep, late-time, high-resolution imaging with ACS/WFC of the sites of two core-collapse SNe 2009kr and 2009md. We aim to: 1) Confirm our original identifications, made in pre-explosion images, by confirming that the progenitors are now missing; 2) Apply image subtraction techniques for this late-time imaging with our pre-explosion images to determine accurate photometry of the progenitors to constrain their temperatures and luminosities; and 3) study the stellar populations in the immediate vicinities of these SNe, previously obscured by the progenitor and the SN, to provide a measure of the progenitor's age, as well. HST provides the unique combination of high-resolution optical/IR imaging at very faint magnitudes that will facilitate this study.
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Proposal Category: GO

Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12560
Title: COS spectra of a Filament in NGC1275 - Testing the Particle Heating Mechanism
PI: Roderick Johnstone
PI Institution: University of Cambridge

Halpha filaments are common in and around the brightest central galaxy in cool-core clusters of galaxies. A spectacular example occurs around NGC1275 in the nearby Perseus cluster. The low ionization spectrum of the filaments does not match that of any Galactic nebula and is not explained by any plausible photoionizing source. We have shown that the spectrum can be accounted for by ionization and excitation by ionizing particles, produced as the surrounding hot gas particles interpenetrate the cold atomic and molecular filament gas. Strong CI 1656A emission is predicted, as is HeII 1640A and a distinctive continuum. These, and other lines in the UV are sensitive to the energy injection mechanism. We propose to obtain a FUV spectrum of the outer horseshoe filament in the Perseus Cluster, using COS, to detect and measure these lines and the continuum to determine how these filaments are powered.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12561
Title: The Weight-Watch Program for Subdwarfs
PI: Wei-Chun Jao
PI Institution: Georgia State University Research Foundation

The mass-luminosity relation (MLR) is one of the most important map in stellar astronomy. The empirical MLR for dwarfs has been done for many years, but we do not even have enough low metallicity stars, the counterpart of dwarfs, for their MLR. This project of "Weight-Watch Program for Subdwarfs" is to establish such empirical MLR for low metallicity stars. We propose to use HST/FGS1r to finish mapping the visual orbit of one important benchmark low metallicity binary. We resolved this double-lined spectroscopic binary in Cycle 15. By combining the SB2 data and our single-epoch HST/FGS1r result, we have estimated their masses and visual orbit, but with errors in excess of 10%. By combining that effort with four additional orbits proposed in Cycle 19, we expect to reduce the mass errors to 5% (or less) and finish this star on the "Weight-Watch program".
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Proposal Category: GO
Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12562
Title: The UV Interstellar Extinction Properties in the Super-Solar Metallicity Galaxy M31
PI: Geoffrey Clayton
PI Institution: Louisiana State University and A & M College

The plethora of new IR data from Spitzer is a great opportunity to better understand the energy budget of galaxies. It is more important than ever that the properties of the dust grains, which are so important in the absorption of stellar photons and re-emission in the IR, be characterized, so that they can be included accurately in the radiative transfer codes. Dust in Solar (Milky Way) and sub-Solar (LMC, SMC) galaxies has been well studied but little is known about dust properties in galaxies with super-Solar abundances. We will

investigate what effects the super-Solar metallicity of M31 has on its dust properties and make a comparison to the dust in the Milky Way as well as the sub-Solar Magellanic Clouds. We also plan to look for the effect of the abundance gradient in M31 by observing dust over a range of galactocentric distances. We plan to take advantage of the high sensitivity and narrow slit of STIS to obtain low resolution UV spectra (1200-3200 A) of a sample of reddened and lightly reddened OB stars to study the wavelength dependence of interstellar extinction in M31. We will construct UV extinction curves for 7 reddened sightlines in M31 using STIS G140L and G230L spectra. This requires pairs of stars with similar spectral types but different reddenings. For the first time, there are enough luminous M31 stars with accurate spectral types to pursue this program. The Maximum Entropy Method will be used to investigate the dust composition and size distribution for the sightlines observed in this program.
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Proposal Category: GO
Scientific Category: COOL STARS
ID: 12563
Title: Very Low-Mass Pleiades Binaries
PI: Trent Dupuy
PI Institution: Harvard University

We propose to advance the understanding of substellar models by developing a homogeneous sample of binaries intermediate between the ages of young star-forming (~few Myr) and field (~few Gyr) populations. We will establish this sample through high-resolution imaging of substellar objects in the Pleiades. The Pleiades is an ideal venue for such a study given its richness, accurate age (130+/-20~Myr), and well-determined distance (120.2+/-1.9 pc). Our sample will more than triple the sample of brown dwarfs observed by HST at the lowest masses (< 0.04 Msun). Combined with previous observations of Pleiades brown dwarfs, we will develop the first large sample of brown dwarf binaries of an intermediate age, which can be used to constrain the binary frequency and separation distribution. Our sample will also set the stage for future dynamical mass measurements in the Pleiades.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12564
Title: Proper Motions along the Sagittarius Stream: Constraining Milky Way Parameters and Dark Halo Shape
PI: Roeland van der Marel
PI Institution: Space Telescope Science Institute

The Sagittarius Stream is the brightest and most prominent stellar stream around the Milky Way (MW), and the only one with a widely agreed upon origin and parent galaxy (the Sgr dSph). It therefore provides a unique tracer to constrain the MW's dark halo. The position, width, distance, mean line-of-sight velocity, and velocity dispersion of the Stream have been mapped in various parts of the sky. Detailed N-body modeling by the CoIs has shown that conflicting past claims about the implied shape of MW dark halo were due to unnecessarily restrictive assumed dark halo geometries, which did not yield a simultaneous fit to all the data. But when a fully general triaxial geometry is allowed (as typical of CDM halos), the best fit is a near-oblate halo with its spin axis perpendicular to the MW disk. Further observational data are needed to validate or refute this very surprising result. We therefore propose

to map for the first time the variation in proper motion along the Stream. The only existing measurements to date, obtained by the CoIs from 90 years of ground-based data, are restricted to the trailing side of the Stream, and have 10 times larger errorbars than achievable with HST. We will target four fields with ACS/WFC for which serendipitous first epoch observations exist in the Archive. Proper motion accuracies near 5 km/s will be achieved by measuring the relative motion between Stream stars and background galaxies, using established techniques developed by us in the context of ongoing programs. The results will provide a large improvement in our understanding of the MW dark halo, solar circular velocity, and Sgr dSph history.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12565
Title: Primordial Carbon Abundances in Extremely Metal-Poor Stars
PI: Ruth Peterson
PI Institution: Astrophysical Advances

We propose a novel approach towards defining the intital carbon abundance of extremely metal-poor stars. We will observe the C I 1930.9A line, which is detectable in unevolved turnoff stars even for [Fe/H] < -3.0. COS 1941A spectra and ground-based echelle spectra of the CH bands at 3142A and 4315A will both be analyzed with theoretical spectral calculations, and the results compared to understand better the effect of atmospheric convective motions on the CH features normally used for carbon determinations. Because the low-excitation C I 1930.9A line is virtually immune from non-LTE effects, the results should place the carbon abundances of these stars on a firm footing, of importance for theoretical scenarios of single star formation at these low metallicities.
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Proposal Category: GO
Scientific Category: COOL STARS
ID: 12566
Title: Warm Coronal Rain on the young sun EK Draconis?
PI: Thomas Ayres
PI Institution: University of Colorado at Boulder

A remarkable FUV spectrum of young solar analog EK Draconis (G1.5V) was taken by COS in Cycle 17. The mere 20-min SNAPshot captured two distinct Si IV flares (T~60,000 K); very broad profiles of Si IV and C II (T~30,000 K); and prominent Fe XXI coronal forbidden line emission (T~10 MK). Curiously, the bright Si IV features were significantly redshifted, suggesting that warm gas must be continually accreting onto the lower atmosphere. This possibly meshes with a new understanding of the solar "coronal heating paradox," whereby the lacy loop-like magnetic structures that define the Sun's "quiet" corona (away from active regions) are very close to potential, and thus cannot carry enough magnetic free energy to heat themselves: the heating must come from elsewhere. That elsewhere possibly has been discovered recently: needle-like jets of hot gas, called Type II Spicules, have been observed blasting from deep in the chromosphere out into the corona, where the ambient magnetic loops trap the upward streaming hot gas, which then cools and eventually falls back to the surface. Ironically, then, the corona was the wrong place to seek the roots of coronal heating: the chromosphere is where the action really is. The EK Dra redshifts perhaps are a glimpse of a super-sized version of the cooling phase

of the solar process. The purpose of this proposal is to utilize STIS and COS to solidify the observational basis for the apparent coronal downdrafts on EK Dra. If the "coronal rain" hypothesis is borne out, it will be an important step toward resolving the long-standing mystery of coronal heating in the Sun and stars.

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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12567
Title: Bridging STIS's Neutral Density Desert
PI: Thomas Ayres
PI Institution: University of Colorado at Boulder

This is a calibration proposal focused on a set of unsupported ND-filtered long slits (31X0.05NDA,B,C) that can be used with the STIS echelles, and which provide attenuations intermediate between the standard spectroscopic slits (0.2X0.06, 0.2X0.09, or 0.1X0.03) and the (only two) supported ND slits: 0.2X0.05ND (ND=2) and 0.3X0.05ND (ND=3). These intermediate ND's (0.6-1.4) potentially are valuable for bright continuum sources, mainly hot stars, for which currently the supported ND slits must be used to mitigate MAMA global count rate violations. Because there is such a large jump from the normal clear spectroscopic slits (ND~0) to the next supported ND step (ND=2), there are many cases where an observation just barely exceeds the global rate with a clear aperture, and therefore must shift to the ND=2 slit; but now requires something like 100 times the exposure duration to achieve a target S/N. Adding the currently unsupported slits to STIS's toolkit will pave the way for more efficient future projects involving echelle spectroscopy, especially for the top tier of bright hot stars not yet observed by this powerful instrument. To qualify the 31X0.05ND slit set, HST standard G191B2B (DA) will be measured to determine wavelength-dependent throughputs across the FUV+NUV range, and across the full field of each MAMA camera. Pole-on rapid rotator Vega (A0V) -- well-known visible photometric standard, and which has a bright, rich, and complex FUV spectrum -- will provide a test for any lineshape degradation by the long slits in the high-res echelle configuration. The high-S/N Vega FUV echelle spectra will have unique scientific value as well.

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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12568
Title: WFC3 Infrared Spectroscopic Parallel Survey WISP: A Survey of Star Formation Across Cosmic Time
PI: 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. 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 260 pure parallel orbits for grism spectroscopy in 26 deep (5 orbit) and 65 shallow (2 orbit) fields. This will complete a sample of ~3500 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<2. (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 dwarf galaxies in galaxy assembly. (4) Use the Balmer break and D4000 diagnostics to find and determine the ages of absorption-line galaxies down to H=25. (5) Search for rare objects such as Lya emitters at z>5.5, reddened AGN, close physical pairs of galaxies, and L- and T-dwarf stars. WISP is likely to be Hubble's principal legacy of 0.8--1.7 um spectroscopy. Our survey will provide a unique data set for characterizing the star formation and chemical evolution histories of galaxies across much of cosmic time, especially in low-mass systems.
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Proposal Category: GO
Scientific Category: AGN/QUASARS
ID: 12569
Title: Ionized and Neutral Outflows in the QUEST QSOs
PI: Sylvain Veilleux
PI Institution: University of Maryland

The role of galactic winds in gas-rich mergers is of crucial importance to understand galaxy and SMBH evolution. In recent months, our group has had three major scientific breakthroughs in this area: (1) The discovery with Herschel of massive molecular (OH-absorbing) outflows in several ULIRGs, including the nearest quasar, Mrk 231. (2) The independent discovery from mm-wave interferometric observations in the same object of a spatially resolved molecular (CO-emitting) wind with estimated mass outflow rate ~3x larger than the star formation rate and spatially coincident with blueshifted neutral (Na ID-absorbing) gas in optical long-slit spectra. (3) The unambiguous determination from recent Gemini/IFU observations that the Na ID outflow in this object is wide-angle, thus driven by a QSO wind rather than a jet. This powerful outflow may be the long-sought "smoking gun" of quasar mechanical feedback purported to transform gas-rich mergers. However, our Herschel survey excludes all FIR-faint (UV-bright) "classic" QSOs by necessity. So here we propose a complementary FUV absorption-line survey of all FIR-bright -and- FIR-faint QSOs from the same parent sample. New (19 targets) and archival (11) spectra will be used to study, for the first time, the gaseous environments of QSOs as a function of host properties and age across the merger sequence ULIRG --> QSO. These data will allow us to distinguish between ionized & neutral quasar-driven outflows, starburst-driven winds, and tidal debris around the mergers. They will also be uniquely suited for a shallow but broad study of the warm & warm-hot intergalactic media, complementary to on-going surveys that are deeper but narrower.
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Proposal Category: GO
Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12570
Title: Deep FUV Imaging of Cool Cores in Galaxy Clusters
PI: Sylvain Veilleux
PI Institution: University of Maryland

We propose to complete an on-going ACS/SBC FUV imaging survey of nearby galaxy cluster cores with the observation of our final 5 targets. This FUV program is the last critical element of a comprehensive investigation of the impact of stellar and AGN feedback on the local galaxy cluster environment. The HST

images complement new, high-resolution, Halpha images obtained with the Maryland-Magellan Tunable Filter (MMTF) on the Baade 6.5m telescope, as well as new optical long-slit spectroscopy from the Magellan and Keck telescopes, Herschel mid-far IR imaging spectroscopy, CARMA, SMA and IRAM sub-mm imaging spectroscopy, and archival Chandra imaging spectroscopy, GALEX NUV imaging, and VLA 1.4 GHz maps. The MMTF data have revealed unsuspected filamentary complexes in several systems. The GALEX data often show hints of extended NUV and FUV emission on a similar scale, but their poor spatial resolution prevents meaningful comparison with the MMTF data. The ACS/SBC data which we acquired during the 2009 supplemental call have provided this much needed gain in resolution, but several of the most exciting Halpha filamentary complexes remain unobserved at FUV. The combined X-ray-FUV-Halpha-IR-radio imaging and X-ray-optical-IR spectra will allow us to derive with unprecedented precision the role of the AGN, hot stars, shocks, and relativistic particles on the excitation and thermodynamics of the multi-phase intracluster and interstellar media in these systems. This is an important question since the formation and evolution of most cluster galaxies have likely been affected by these processes.
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12571
Title: The Crab Halo
PI: Peter Lundqvist
PI Institution: Stockholm University

The Crab Nebula, along with its central pulsar and its explosive origin in SN 1054, plays a crucial role in our understanding of the link between supernovae and pulsar formation and activity. Yet, there are fundamental uncertainties in the nature of the event that have not been settled in more than two decades of investigation. The observed mass in the nebula and pulsar is nearly half of the expected initial stellar mass and the observed energy (much of which may come from the central pulsar) is only a few percent of the typical supernova energy. An attractive solution to this ``missing mass'' problem is that this mass is in a high velocity envelope around the observed Crab Nebula. The envelope would have most of the energy of the explosion (roughly 10^{51} ergs), bringing the energy up to that typical of a Type II supernova. The fact that the Crab filaments have a measured acceleration and show no deceleration at the outer edge is consistent with this hypothesis. The lack of an interaction region created by the fast shell can be attributed to a very low density around the supernova. We propose to search for the fast shell by taking a COS spectrum of the Crab pulsar in the region of the C IV 1550 line. We have carried out time-dependent ionization calculations that show that this line should produce a detectable broad, blueshifted absorption if the shell is present.
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Proposal Category: GO
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12572
Title: The Brightest of Reionizing Galaxies Pure Parallel Survey
PI: Michele Trenti
PI Institution: University of Colorado at Boulder

Hubble's WFC3 discovered dozens of galaxies at z~8 in the HUDF and GOODS-S fields, but the majority are faint M>M* objects, which hardly constrain the

bright end of the z~8 luminosity function. The best strategy to spot rare M<M* sources is a large-area medium-deep survey. The optimal tactic is a pure-parallel survey along random pointings: this minimizes cosmic variance, a serious concern in the search for highly clustered luminous galaxies. In Cycle 17 we started the BoRG survey, now covering ~130 arcmin^2 with 19 z~8 candidates. We propose to augment its area by ~270 arcmin^2 with 260 pure-parallel orbits, to keep hunting for the brightest galaxies at z~8. We expect to detect more than 30 new z~8 candidates, constraining their number density to 15% accuracy and finding 4-6 ultra-bright sources (m_AB<26) for spectroscopic follow-up with 8m-class telescopes. These galaxies are promising tracers of galaxy proto-clusters, as indicated by theoretical models and proven by our Cycle 17 data. We will select Lyman Break Galaxies at z>7.5 as Y-dropouts down to m_AB=27.05 (5 sigma) in F125W, using four-to-five orbit visits and four filters (V: F606W; Y: F098M; J: F125W; H: F160W). The filters used and their depths are optimized to remove contamination from low-redshift galaxies and cool stars. The depth and area of BoRG lies between the "deep" and "wide" part of the CANDELS treasury survey, but BoRG will have the largest area with Y, J & H band coverage, needed to search for z~8 galaxies. The dataset will also open additional galactic and extragalactic scientific avenues. We waive data proprietary rights and commit to release final images and catalogs, as done for Cycle 17 data.
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12573
Title: STIS Coronagraphy of New Debris Disks from the WISE All-Sky Survey
PI: Deborah Padgett
PI Institution: California Institute of Technology

Debris disks trace the collisional breakdown of asteroid and comet parent bodies orbiting nearby main sequence stars. While present in ~15% of FGK stars - as diagnosed by infrared excess measurement by IRAS, ISO, and Spitzer - only 6 debris disks have been detected in scattered light around late-type stars. The detectability of debris disks in scattered light trends strongly with the magnitude of their infrared excess, so progress in this field depends on identifying new stars with strong excess. The Wide-Field Infrared Survey Explorer (WISE) has just completed new, sensitive all-sky mapping in the 3.3, 4.6, 12, and 22 micron bands. Association of the WISE sources to Hipparcos stars has led to the identification of 320 nearby main sequence stars with robustly detected warm 22 micron excesses not previously known. We propose STIS coronagraphic imaging of the six brightest and nearest debris disks that WISE has found in association with solar-type stars; all six have excesses stronger than the successfully imaged disk of HD 107146. Our goal is to obtain the first resolved images of these disks at ~5 AU resolution, define the disk sizes and orientations, and uncover disk substructures indicative of planetary perturbations. The results should double the number of debris disks imaged around late-type stars, opening a wider window into the structure of planetary systems.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12574
Title: The Final Word on the Progenitor of the Type II-Plateau Supernova SN 2006ov

PI: Douglas Leonard
PI Institution: San Diego State University

Despite recent rapid progress, the field of supernova (SN) progenitor identification remains in its infancy, with only five supernovae having had unambiguous detection and characterization of their progenitor stars made. The existence of deep pre-SN WFPC2 images of the site of the nearby core-collapse (Type II-Plateau) SN 2006ov has enabled two independent searches for its progenitor star to be carried out. While both studies agree that an object is located at the location of SN 2006ov in the pre-SN images, they disagree on whether the light from this source (or, part of it) is, in fact, coming from the actual progenitor star. The time is ripe to settle the issue: A single-orbit reobservation of the SN site with HST/ACS will permit the definitive determination of whether this object is indeed associated with SN 2006ov. If it is, and its flux is found to have diminished (it was an extended source) or vanished (it was an isolated star), then this will enable the third conclusive characterization of a Type II-Plateau supernova's progenitor star's properties to be made. If it is not, then a firm upper mass limit on the progenitor star will be confidently declared the final word on the topic.
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Proposal Category: GO
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12575
Title: New Constraints on Intragroup Light and the Baryon Budget in Galaxy Groups
PI: Anthony Gonzalez
PI Institution: University of Florida

We propose a focused WFC3/IR imaging program targeting galaxy groups at z=0.3-0.5 to better understanding why the partitionings between baryon phases (gas vs. stars) and stellar components (within vs. outside galaxies) show such strong variation from groups to rich clusters. We will 1) obtain the first complete census of stars both in and out of group galaxies for a representative sample of groups and 2) use the luminosity distribution and colors of the intragroup stellar populations to constrain the galactic population from which the stars were stripped. As demonstrated by our Cycle 16 program on the Bullet Cluster, WFC3 offers a major step forward for studies of such diffuse stellar populations, enabling a vast improvement over previous ground-based studies of intracluster/intragroup light and total baryon content in groups and clusters. We will use the sample from this program in conjunction with the clusters from the CLASH Multicycle Treasury Program to quantify the total stellar baryon content in clusters and groups spanning more than a dex in mass. We will also unambiguously determine the progenitor galaxy population from which the ICL is assembled.
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Proposal Category: GO
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12576
Title: Orbit determination for Fomalhaut b and the origin of the debris belt halo
PI: Paul Kalas
PI Institution: University of California - Berkeley

HST has a unique capability to detect tenuous debris disks and exosolar

planets at optical wavelengths. Using the ACS/HRC in 2004-2006, we imaged the debris belt surrounding Fomalhaut, finding evidence for a planetary system in the structure of the belt, and then directly imaging a planet candidate, Fomalhaut b (Fom b). New STIS data recover Fom b in 2010 with the expected flux and near its expected position. We also discover a tenuous belt halo extending 30 AU beyond the previously measured outer belt edge. These grains may be driven outward by radiation pressure or dynamically perturbed by Fom b. We propose a long-term GO program dedicated to the study of the orbit of Fom b and its interaction with this newly discovered halo. The goals are to constrain the orbital elements of Fom b and establish with confidence that it is bound. The proposed astrometry is designed to measure the eccentricity with sufficient precision to discriminate between a circular orbit and one that is nested within the belt with e ~ 0.12. STIS is the only instrument demonstrated able to make these astrometric observations. To pinpoint the origin of grains that comprise the belt halo, we propose to obtain the halo scattered light color by direct imaging in F336W and F814W using WFC3/UVIS. If the main belt and halo share the same color (as opposed to blue Rayleigh-scattering grains) then planetary dynamical perturbations will be suspected. The UVIS F336W observations leave open the possibility of detecting Fomalhaut b at short wavelengths, testing the hypothesis that Fom b is optically bright due to scattering from an extended circumplanetary ring system such as that found around Saturn.
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12577
Title: Spectral Time Series of the Cas A Supernova
PI: 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.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12578
Title: Constraints on the Mass Assembly and Early Evolution of

z~2 Galaxies: Witnessing the Growth of Bulges and Disks
PI: N. Forster Schreiber
PI Institution: Max-Planck-Institut fur extraterrestrische Physik

Motivated by both observational and theoretical developments, a new picture is emerging in which rapid but fairly smooth mass accretion and efficient secular processes play a major, if not dominant, role in the early evolution of massive galaxies. The proposed program will test this scenario through sensitive high-resolution WFC3/IR F160W and F110W imaging of 21 massive star-forming galaxies at z~2 with adaptive optics (AO) assisted VLT/SINFONI near-IR integral field spectroscopy. This is a truly unique sample, with detailed Halpha maps and kinematics resolved on ~1-2 kpc scales. WFC3/IR F160W+F110W imaging at similar resolution will provide the missing but crucial information on the bulk of stellar populations, from rest-frame optical continuum morphologies and colors optimized for measuring the age-sensitive Balmer/4000A break. This is essential to determine the detailed structure of galaxies, and the distribution of stellar mass, M/L ratio, and relative ages within them. The proposed data will directly tackle some of the most fundamental open issues concerning the formation of massive spheroids and disks, including the role of disk instabilities and minor/major merger events in the formation of bulges. The powerful combination of WFC3/IR imaging for the stellar component and SINFONI/AO data for the dynamics and on-going star formation will provide an unprecedented view of the stellar and dynamical evolution of galaxies at z~2, the epoch of major buildup of the most massive ellipticals, bulges, and thick disks.
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Proposal Category: GO
Scientific Category: AGN/QUASARS
ID: 12579
Title: AGN feedback in young, radio-loud AGN
PI: Joanna Holt
PI Institution: Sterrewacht Leiden

AGN feedback is now routinely included in both galaxy evolution models and cosmological simulations yet large uncertainties remain about the most important parameters, such as the mass outflow rates, bulk kinetic powers and the dominant outflow driving mechanisms. In order to address this issue, we propose to make HST ACS/WFC observations of a small, complete sample of compact (young) radio sources which have clear evidence for strong emission line outflows. Compact radio sources are ideal sources for studying AGN feedback as in addition to begin young, recently triggered AGN, all potential outflow drivers are present in these sources (AGN winds/starbursts/radio jets). We will use the unique capablilities of HST ACS/WFC to map the outflowing regions with high spatial resolution to determine the dominant outflow driving mechanism. Furthermore, the morphological information, in combination with our new high resolution VLT/X-Shooter spectra (which cover the entire optical - near-IR wavelength range simultaneously), will allow us to accurately calculate the outflow energetics in these sources. Such studies are crucial for determining whether AGN feedback in real galaxies can achieve the requirements made by simulations.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12580
Title: A 'Rosetta Stone' to Interpret the UV-HST Photometry of

Multiple Stellar Populations in Globular Clusters
PI: Alvio Renzini
PI Institution: Osservatorio Astronomico di Padova

In this proposal we intend to firmly identify the chemical species responsible for the UV and UV-optical color differences exhibited by the multiple stellar populations harboured by two Galactic globular clusters: omega Centauri and 47 Tucanae, one with highly helium enriched sub-populations (omega Centauri), the other not. We plan to collect ultraviolet STIS spectra for stars in the crowded cores of the clusters, where HST photometry is already available for thousands of stars in more than 10 filters, from F225W to F850LP. This WFC3+ACS photometric database has allowed us to show that UV colors are remarkably effective in separating the different cluster sub-populations, and with the proposed STIS spectroscopy we can quantify the chemical abundance differences among such sub-populations, most notably in Nitrogen and Oxygen. The resulting calibration of the UV colors in terms of CNO abundances will provide a new effective tool for the chemical characterization of large numbers of globular cluster stars belonging to the various sub-populations in each cluster, and to better isolate the specific role of the helium abundance. The plan is to observe at least one star for each of the main principal stellar sub-populations in each of the two clusters. These objects are selected on the basis of their accurate photometry and astrometry already in hand, based on existing UV-HST images.
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Proposal Category: GO
Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12581
Title: A Direct CO/H2 Abundance Measurement in Diffuse and Translucent LMC and SMC Molecular Clouds
PI: Julia Roman-Duval
PI Institution: Space Telescope Science Institute

Theoretical and observational evidence suggests that molecular gas (H2) is not always correlated with CO because CO is photo-dissociated more easily than H2. The mass of CO-poor H2 present in the envelopes of giant molecular clouds (GMCs) is higher in low metallicity GMCs, which are more exposed to dissociating radiation due to their lower dust abundance. Since we cannot detect H2 directly, the mass of these CO-poor envelopes is effectively "hidden" from radio telescopes. This limitation of CO emission observations hinders our understanding of the correlation between star formation rate, H2, and CO since, in those low metallicity galaxies, neither the CO/H2 abundance, nor the H2 mass can be accurately derived from CO emission. The most sensitive and direct way to determine CO and H2 column densities is to derive them from UV absorption lines. Because of their proximity and low metallicity, the Magellanic Clouds are ideal laboratories to test the current theory of CO/H2 abundance, which can be applied in the high-redshift universe. We propose to observe the 4th positive absorption band of CO with COS toward 9 translucent (Av~1) Magellanic Cloud sightlines probing the edges of GMCs. Covering the Lyman-Werner bands of H2, readily available FUSE spectra can be used to derive H2 column densities toward our targets. These COS observations, which are the only direct test of theoretical predictions for the CO/H2 abundance, will detect CO column densities as low as 1e13 cm-2. They will constrain the structure of GMCs in low-metallicity galaxies, the CO-to-H2 ratio required to estimate the H2 mass from CO emission, and the correlation between star formation rate, H2, and CO.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12582
Title: Probing the explosion environment and origin of Type Ia supernovae
PI: Ariel Goobar
PI Institution: Stockholm University

We propose a novel set of photometric and spectroscopic HST observations of near-by Type Ia supernovae to address and possibly resolve some of the outstanding questions with regards to the use of SNe Ia as distance estimators: the understanding of the non-standard color-brightness relation and the properties of the progenitor system. Thanks to the great sensitivity of WFC3 at UV and near-IR wavelengths, we will be able to differentiate reddening models that give approximately the same colors in optical bands but resulting in sizable bias for cosmology. Moreover, STIS spectra of moderately reddened supernovae can be used to, for the first time, detect the 2175Å absorption feature from (non-Galactic) dust in SN Ia spectra. This would uniquely identify the dust-related part of the observed anomalous brightness-color relation. The spectroscopic data will also be used to quantify the impact of metallicty in the peak brightness, and to test SN Ia models with significant interactions with the circumstellarenvironment, as expected in the single degenerate scenario. The proposed observations have the power to discriminate between practically all astrophysical processes that have been suggested as possible limitations for the ultimate accuracy of distance estimates to SNe Ia.
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Proposal Category: GO
Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12583
Title: Spectro-LARS: ISM Kinematics of the Lyman-alpha Reference Sample
PI: Matthew Hayes
PI Institution: Observatoire Midi-Pyrenees

The Lyman-alpha emission line is the pivotal spectral feature in both the identification of high-redshift galaxies and the confirmation of candidates. In this respect Ly-alpha promises to realize many of the fundamental goals of galaxy evolution astrophysical cosmology. Unfortunately the line is a resonance one, and suffers a radiation transport that is intricate and complicated -- despite thousands of high-z galaxies having been found through Ly-alpha, it is still not known which physical properties of galaxies fundamentally determine the line visibility and how they intertwine. Galaxies at high-z are typically too faint to study at the necessary levels of detail, and spectral features for benchmark and calibration are redshifted to wavelengths where they are undetectable. To resolve these issues we began a Ly-alpha imaging program, targeting 14 nearby galaxies in HST cycle 18: LARS -- the Lyman-alpha Reference Sample. LARS will consist of a public access data release and will address many aspects of Ly-alpha transport, such as dust-content and characteristics of the stellar population. Without ultraviolet spectroscopy, however, the LARS data-set will have no measurements of the neutral gas kinematics - something that is qualitatively known to be of great significance to Ly-alpha escape. Quantitatively, however, the case is far from resolved. We will finally obtain this information by completing our HST data-set with far-ultraviolet spectroscopy from the Cosmic Origins Spectrograph.

With 49 primary orbits dedicated to LARS, and further reliance on 31 orbits of archival data, the award of just 7 more orbits in cycle 19 will allow us to resolve this point.
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Proposal Category: GO
Scientific Category: AGN/QUASARS
ID: 12584
Title: Confirming the First Supermassive Black Hole in a Dwarf Starburst Galaxy
PI: Amy Reines
PI Institution: The University of Virginia

In the modern universe, supermassive black holes lie at the heart of most, if not all, galaxies with bulges. However, the birth and growth of the first "seed" black holes, back in the earlier universe, is observationally unconstrained. Reines et al. (2011) have recently discovered a candidate million-solar mass black hole in the bulgeless dwarf starburst galaxy Henize 2-10, offering the first opportunity to study a growing black hole in a nearby galaxy much like those in the infant universe. The case for an accreting black hole in Henize 2-10 is strong (e.g. co-spatial non-thermal radio and hard X-ray point sources), but not watertight. Our proposal aims to confirm (or refute) the presence of this candidate black hole using STIS optical spectroscopy to trace the kinematics and ionization conditions in its immediate vicinity. Existing HST observations show a marginally resolved H-alpha knot coincident with the radio and X-ray point source, so our primary aim is to detect a compact rotating disk of ionized gas, directly yielding a black hole mass. Our secondary aim is to find evidence for AGN-related emission line signatures at the location of the H-alpha knot, and possibly along a narrow jet-like filament. Confirming the presence of a supermassive black hole in Henize 2-10 with these HST observations has immediate implications for our understanding of the birth and early evolution of the first black holes in the high-redshift universe.
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Proposal Category: SNAP
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12585
Title: Unveiling the Physical Structures of the Most Luminous IR Galaxies Discovered by WISE at z>1.6
PI: Sara Petty
PI Institution: University of California - Los Angeles

WISE recently completed the first all-sky infrared survey since IRAS, pushing hundreds of times deeper. The search for the most extreme and rare ULIRGs has been successful, providing a unique opportunity to study the astrophysical origin and structural environments at the extreme end of the luminosity function. Extreme ULIRGs, such as the WISE color-selected sample, are powered by rapid star formation and/or AGN heavily obscured by dust, and are likely in a late stage merger process. WISE ULIRG color-selections have resulted in a sample of 53 confirmed z>1.6 galaxies that do not fit standard dusty luminous-IR SEDs. Their structural properties are also unknown, due to a lack of high-resolution near-IR imaging. We propose a SNAP proposal to obtain WFC3/F160W images of 53 z>1.6 WISE color-selected ULIRGs for the primary purpose of calculating the quantitative morphologies, probing the restframe UV-optical stellar populations. WFC3/F160w imaging provides the resolution needed to resolve clumpy structure or multiple nuclei within ~1 kpc (at z ~2), and the

sensitivity to detect faint surface brightness features which remain a key factor in determining accurate light profiles and merger scenarios that produce extended physical structures. The 53 WISE-selected ULIRGs are distributed throughout the sky, providing a convenient Snapshot target list. A significant result from WFC3/F160W imaging is the quantitative measurements of the relative fraction of AGN vs starburst powered ULIRGs, lending insight into the co-evolution of black holes and galaxies in the Universe and constraining the dynamics and structures of extreme phases in galaxy evolution.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12586
Title: Detecting and Measuring the Masses of Isolated Black Holes and Neutron Stars through Astrometric Microlensing
PI: Kailash Sahu
PI Institution: Space Telescope Science Institute

We propose a 3-year program of monitoring of 12 fields in the Galactic bulge, containing a total of ~1.5 million stars down to V=28. Our primary aim is to detect microlensing events caused by non-luminous isolated black holes (BHs) and neutron stars (NSs) in the Galactic disk and bulge. The unique capability of HST imaging for microlensing observations is the addition of high-precision astrometry, allowing detection of the astrometric shift of the source during the event. Combined with the lens parallax, provided by the HST event light curve, the astrometric shift provides a direct measurement of the lens mass. We will detect ~120 microlensing events, of which 45% will show astrometric deflections, leading to direct determinations of the lens masses. Of these, about 18 lenses are expected to be BHs and 14 of them NSs, along with about 22 events due to main-sequence stars. To date, BH and NS masses have been directly measured only in binaries; no isolated BH has been detected unambiguously within our Galaxy. A survey of the scope proposed here is the only means available at present for measuring the mass function of isolated BHs and NSs, and moreover one that is normalized to that of luminous stars. The results will provide a quantitative estimate of the mass content in the form of stellar remnants in the young Galactic disk and old bulge, and important constraints on SN/GRB explosion mechanisms that produce NSs and BHs. Our data will also be useful for other investigations, including a more accurate determination of the microlensing optical depth, faint variable stars, bulge proper motions and kinematics, and a deep luminosity function of the disk and bulge stars.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12587
Title: Winds of very low metallicity OB stars: crossing the frontier of the Magellanic Clouds
PI: Miriam Garcia
PI Institution: Instituto de Astrofisica de Canarias

Very low metallicity massive stars are a key ingredient for our understanding of the early Universe because of their connection with the dominant conditions at that time, the reionization epoch and long-GRBs. In the studies of massive stars radiation driven winds play a crucial manifold role, being a chief agent of stellar evolution, altering the optical diagnostics for parameter determination and injecting radiative and mechanical energy into their

surroundings. However, the theory of radiation driven winds has only be tested down to SMC metallicities and some important open questions remain: the existence of solar-metallicity stars with weak winds and very recent evidence of relatively strong winds in metal-poor stars. We have secured VLT optical spectra of a sample of early-type massive stars in IC 1613, a very metal poor (~<0.1Zo) irregular galaxy of the Local Group that represents the next step towards low metallicities after the SMC. We request low resolution COS spectra (COS/FUV-G140L) of a sub-set of OB stars probing different wind regimes. The wind lines in the 1150-1800A range, together with the optical spectra, will allow us to derive consistently the photospheric and wind parameters of the sample. Results will be interpreted in the context of both evolutionary and radiatively driven winds theories, testing the current paradigm at unexplored low metallicities and increasing our knowledge of massive stars under conditions closer to those of the deep Universe. COS enhanced sensitivity will allow us to perform for the first time detailed studies of **resolved** OB stars in an environment with poorer metal content than the SMC.
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Proposal Category: GO
Scientific Category: COOL STARS
ID: 12588
Title: Accurate Mass Determination of the Old White Dwarf G105-30 through Astrometric Microlensing
PI: Kailash Sahu
PI Institution: Space Telescope Science Institute

We propose to determine the mass of the cool, nearby, high-proper-motion white dwarf (WD) G 105-30 (LHS 1838) through astrometric microlensing. In a reprise of the famous 1919 solar eclipse that verified general relativity, G 105-30 will pass very close in front of a 19.5-mag background star in June 2012, with an impact parameter of only ~0.08 arcsec. As it passes in front, it will cause a relativistic deflection of the background star's image by >2 milliarcsec, an amount easily detectable 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 distance to G 105-30 is already known from an accurate parallax, and the relative 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%, potentially <1% for favorable circumstances). One key astrophysical prediction for WDs is the existence of a mass-radius relation (MRR), which depends on the WD's core composition. Since the luminosity and distance of G 105-30 are known, its radius is known. Our measurements will thus provide a new, precise point in the MRR. The mass of G 105-30 is of special interest because it is an old and relatively massive WD, which would provide new constraints near the bottom of the WD cooling curve, currently being used to age-date stellar populations.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12589
Title: The Current Ultraviolet Spectrum of S Doradus: As Hot as it Gets
PI: Noel Richardson
PI Institution: Georgia State University Research Foundation

We propose to measure the ultraviolet flux of the prototype of the Luminous Blue Variables (LBVs) in the LMC, S Doradus, as it goes into the current

optical minimum that corresponds to a maximum ultraviolet flux. During this time, the strength of the optical wind line H-alpha grows, with several high excitation emission lines emerging from the wind. In a similar state, the Galactic LBVs AG Carinae and HR Carinae have been found to show signs of rapid rotation. We aim to measure accurately the bolometric luminosity of this star at a visual minimum, examine the wind sensitive lines in the ultraviolet such as Si IV 1400, C IV 1550, and Mg II 2800, and determine a projected rotational velocity at this epoch. These observations can only be made with the echelle mode of HST/STIS, and they will help reveal the stellar and wind properties of one of the brightest stars in the Large Magellanic Cloud at an epoch when we view deep into its atmosphere.
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Proposal Category: GO
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12590
Title: Galaxy Assembly at High Densities: HST Dissection of a Cluster at z=1.62
PI: Casey Papovich
PI Institution: Texas A & M Research Foundation

The study of high redshift cluster galaxies near the epoch at which they form their stars provides the most diagnostic power on models of galaxy formation, which make strong predictions for galaxy evolution in these high density environments. This motivates the study of cluster galaxies at redshifts > 1.5, where most of the stars in cluster galaxies form, and the clusters assemble. Here we propose a detailed study of galaxy evolution in one galaxy cluster at z=1.62 using HST/ACS and WFC3 imagining, and WFC3 spectroscopy. This galaxy cluster was identified solely as an overdensity of Spitzer/IRAC sources with red IRAC colors, with little bias toward optically red or blue galaxies. The cluster has only 12 spectroscopic redshifts, mostly for active and star-forming galaxies, and measuring redshifts for most of the passive galaxies is beyond the capabilities of ground-based telescopes. The scientific goals of this proposal are (1) to measure spectroscopic redshifts of the red, passive galaxies to J(AB)=22.8 mag (~J* + 1 mag) in this cluster with the WFC3 grism in order to confirm cluster members and map the cluster in redshift space, (2) to measure the strength of the 4000 Angstrom/Balmer break from the grism spectra, providing valuable information on the galaxy stellar population ages and masses, (3) to measure the spatially resolved structures and faint, H(AB)=26 mag, subcomponents in these galaxies, constraining their assembly and formation histories, and (4) to use these observations to make comparisons to expectations from theoretical galaxy formation models.
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Proposal Category: SNAP
Scientific Category: AGN/QUASARS
ID: 12591
Title: A Chandra/HST census of accreting black holes and nuclear star clusters in the local universe
PI: Elena Gallo
PI Institution: University of Michigan

We propose a snapshot survey of a sample of 31 faint nearby spheroidal galaxies with faint X-ray cores with ACS. These observations will complement an approved Chandra program which targets 100 field spheroids within 30 Mpc, searching for low level accretion-powered emission from nuclear super-massive black holes. The resolution of ACS will enable us to infer the presence of

nuclear star clusters, determine their stellar mass if present, and thus effectively correct for contamination from low-mass X-ray binaries to the nuclear X-ray emission detected by Chandra. Combining this new program with our well matched Virgo cluster survey (also Chandra/HST), we will be able to investigate and compare accretion-powered activity from local super-massive black holes over two well controlled-samples of field as well as cluster spheroidal galaxies, and to do so down to unprecedented low Eddington ratios.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12592
Title: Understanding the Progenitor Systems, Explosion Mechanisms, and Cosmological Utility of Type Ia Supernovae
PI: Ryan Foley
PI Institution: Smithsonian Institution Astrophysical Observatory

Despite spending >2000 HST orbits on observations of high-redshift Type Ia supernovae (SN Ia), where observations at z > 1 exclusively probe the rest-frame UV, there is only one published high-quality true UV spectrum of a SN Ia within a week of maximum brightness - and this spectrum was from Cycle 1 in 1992. We propose to obtain STIS spectroscopy of three nearby SN Ia from about a week before maximum brightness until about 20 days after maximum brightness. By obtaining spectra every 4 days, we will be able to model the ejecta abundances as the photosphere recedes with time - like a CAT scan. Since the UV SED is extremely sensitive to several parameters like progenitor metallicity, intermediate mass element generation, and 56Ni mixing, these data (in conjunction with OIR observations obtained from the ground) will be the most constraining yet for SN Ia models. Similar data have never been obtained. In addition to furthering our understanding of SN Ia progenitor systems and explosions, we will use these data to directly improve the utility of SN Ia as cosmological distance indicators. These SN Ia will be the best observed and best studied SN Ia ever. This is our best opportunity to further our understanding of these objects.
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Proposal Category: GO
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12593
Title: A Survey of Atomic Hydrogen at 0.2 < z < 0.4
PI: Daniel Nestor
PI Institution: University of California - Los Angeles

Presently, the role of cool gas in galaxy evolution is poorly constrained by observations. 21cm studies map HI in the very local Universe, but not to cosmological distances, and while many data exist for damped Ly-alpha (DLA) absorbers at z>2, the limitations at high-z make their interpretation difficult. Redshifts z<1.65 were finally probed in our HST cycles 6, 9 and 11 Ly-alpha absorption surveys, and using MgII absorbers through our surveys in the SDSS quasar spectra and our own MMT survey. While these works have contributed greatly to our understanding of cool gas in galaxies across the past ~10Gyrs, the lowest redshifts - where there exists the potential to connect the results from high-z absorption-based studies to that of local emission-based work - remain poorly probed. Thus we propose to obtain COS FUV spectra of 19 known MgII absorption systems at 0.2<z<0.4 to determine their HI column densities. We expect to double the number of classically-selected DLAs

and subDLAs in this redshift range. Our targets have known, relatively bright FUV magnitudes and are screened for higher-z absorption systems which could absorb flux at the location of our target Ly-alpha line. Thus we expect a ~100% success rate at detecting and measuring high column density HI systems. In addition to measuring the cosmic density of HI at an epoch intermediate to current high-z and local measurements, these observations will provide unique and invaluable laboratories that can provide constraints on our understanding of metal-line absorbers, cool-gas accretion, processes involving the reservoirs of gas for star formation, and galactic-outflows/IGM-enrichment.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12594
Title: The White Dwarf Mass-Radius Relation Based on Dynamical Masses: STIS Observations of Close Double Degenerates
PI: Edmund Nelan
PI Institution: Space Telescope Science Institute

This is a proposal to add six new white dwarfs (WDs) to the mass-radius relation for WDs, thus providing a stringent new test of our understanding of WD physics. For the past several years, we have had underway programs of HST/FGS astrometry of three close visual binaries in which both components are WDs. The astrometry is yielding precise, model-independent dynamical masses for these six WDs. To complete the investigation, we need to obtain flux-calibrated spectra of the individual WDs in these binaries, which, combined with the accurate parallaxes from the FGS data, yield the radii. All three binaries are too close together for individual spectra to be obtained from the ground, but they can be obtained easily with STIS. By using an optimal telescope roll angle, we can obtain both spectra simultaneously in a single STIS exposure. Two of the binaries are bright enough to obtain the spectra in one orbit. The third, faintest target requires 2 orbits. In order to observe the closest of the binaries at maximum separation, its observation should be done a few months after the beginning of Cycle 20.
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Proposal Category: GO
Scientific Category: AGN/QUASARS
ID: 12595
Title: Unraveling the LINER Conspiracy
PI: Michael Eracleous
PI Institution: The Pennsylvania State University

LINER nuclei, the low-accretion-rate states in which SMBHs spend most of their lifetimes, are critical for understanding the AGN phenomenon in the context of galaxy evolution as a whole. Observations have clearly established the presence of BH-related activity in many LINERs. However, it has also become clear that the line emission on ~1'' (~100 pc) scales, used for LINER classification in ground-based data, is unbalanced by the energy output of the nucleus alone. An unknown additional power source conspires with the nucleus to produce the observed LINER spectrum and luminosity. Our understanding of LINERs is thus fundamentally incomplete. We propose UV/optical spectroscopy, spatially resolving the 0''-1'' scale, for three bright, nearby, and prototypical LINERs. All three have multiple AGN indications, but ionizing photon deficits, and all three have archival HST data with radial emission-line profiles in the H-alpha region. Complementing these with similar H-beta region data, we will probe for the first time, using standard line

diagnostics, the gas excitation with increasing distance from the photoinizing sphere of influence of the nucleus with a resolution of ~10 pc. Similar data in the near UV will reveal or place limits on the nature of the additional power sources: shocks, or young or old stars.
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Proposal Category: GO
Scientific Category: COOL STARS
ID: 12596
Title: In Search of a Young Solar Wind
PI: Brian Wood
PI Institution: Naval Research Laboratory

There are three main reasons why we would very much like to know how the coronal winds emanating from the Sun and other solar-like stars evolve with time. 1. Stellar winds have important effects on planetary atmospheres, with Mars being a particularly important example in our own solar system. 2. Stellar winds may contribute to the dissipation of debris disks. 3. Stellar winds play a central role in the angular momentum and activity evolution of cool main sequence stars. The best way to investigate stellar wind evolution is to detect and measure the winds of solar-like stars of various ages to see how they change with time. Unfortunately, detecting coronal winds is extremely difficult. The only detections to date come from high resolution HST Lyman-alpha spectra of nearby stars, which sometimes show absorption from the stellar "astrospheres" (i.e., interaction regions between stellar winds and the ISM). The amount of absorption can be used as a diagnostic of the stellar wind strength. There are 13 astrospheric detections so far, but unfortunately there are still no unambiguous detections for any true young, solar analogs. We here propose to try to rectify this situation by observing four young, very active solar-like stars with HST/STIS, in the hopes that at least one or two will yield an astrospheric detection that can finally tell us what coronal winds are like for young F and G stars. Success would mean a major step forward in being able to address the question of how winds evolve for solar-like stars, and how that affects the planets and disks that surround them.
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Proposal Category: GO
Scientific Category: SOLAR SYSTEM
ID: 12597
Title: Hubble Imaging of a Newly Discovered Main Belt Comet
PI: David Jewitt
PI Institution: University of California - Los Angeles

We seek two orbits of Target of Opportunity (ToO) time to secure exploratory observations of a main-belt comet (MBC), should one be discovered in the upcoming proposal cycle. The observations will be used to determine the early-time morphology and to assess its rate of change by comparison of data from two epochs. The ToO data are needed to determine the optimum strategy for subsequent observations, intended to characterize the MBC at the highest resolution and so to determine the driver of the cometary activity. Our previous Hubble observations of MBCs P/2010 A2 and (596) Scheila were obtained in emergency mode through Director's Discretionary Time requests. The Director's office has suggested that we propose to follow up future MBC discoveries as a ToO, so that HST observations could begin sooner.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12598
Title: HST Observations of Astrophysically Important Visual Binaries: Calibrating Sirius and Procyon
PI: Howard Bond
PI Institution: Space Telescope Science Institute

We have an ongoing long-term program, renewed in Cycle 18 for 3 years, in which we are imaging several important visual binaries, including Sirius and Procyon. The aims of this astrometric program are to determine precise dynamical masses for the white-dwarf and main-sequence components of the binaries, and to search for (or set limits on) third bodies in the systems down to planetary masses. With the advent of WFC3 in our program, we are forced to saturate the images of Sirius A and Procyon A, and instead use the diffraction spikes to infer their centroid locations. In order to calibrate the use of the spikes against the conventional method of centroiding an unsaturated image, which is the method used for the much fainter white-dwarf companions, we request one orbit for imaging of a fainter A-type star. For this star it is possible to obtain both unsaturated images for conventional centroiding and deeper saturated images to which we can apply our diffraction-spike algorithm and derive the offsets. We can thus apply corrections to our diffraction-spike-based astrometry of the saturated Sirius A and Procyon A images, reducing the systematic errors to below 1 mas, and setting tight limits on third bodies. We will not request any additional funding if this supplemental request is approved, and we will waive the proprietary period.
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12599
Title: The Light Echoes around V838 Monocerotis
PI: Howard Bond
PI Institution: Space Telescope Science Institute

V838 Monocerotis, which burst upon the astronomical scene in early 2002, is a completely unanticipated new object. It underwent a large-amplitude and very luminous outburst, during which its spectrum remained that of an extremely cool supergiant. A rapidly evolving set of light echoes around V838 Mon was discovered soon after the outburst, and quickly became the most spectacular display of the phenomenon yet seen. These light echoes provide the means to accomplish three unique types of measurements based on continued HST imaging during the event: (1) Study effects of MHD turbulence at high resolution and in 3 dimensions; (2) Construct the first unambiguous and fully 3-D map of a circumstellar dust envelope in the Milky Way; (3) Study dust physics in a unique setting where the spectrum and light curve of the illumination, and the scattering angle, are unambiguously known. We have also used our HST data to determine the distance to V838 Mon through a novel direct geometric technique, and the results showed that V838 Mon had a maximum luminosity brighter than a classical nova. Because of the extreme rarity of light echoes, this is almost certainly the only opportunity to achieve such results during the lifetime of HST. Similar intermediate-luminosity red transients are now being discovered in nearby galaxies, and it has become important to understand the physics of their outbursts and the nature of their progenitors. We propose one visit during Cycle 19, using ACS, in order to continue the mapping of the circumstellar dust and to accomplish the other goals listed above.
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12600
Title: Carbon and Nitrogen Enrichment Patterns in Planetary Nebulae
PI: Reginald Dufour
PI Institution: Rice University

The goal of this project is to assess the role played in carbon production by low and intermediate mass stars (LIMS), i.e. the progenitors of planetary nebulae (PNe). One of the most pressing problems in galactic chemical evolution today is understanding the relative roles of LIMS (1-8 M_sun) versus massive stars (8-120 M_sun) in affecting the cosmic level of the element C. We are launching a fresh, ambitious project whose purpose is to employ STIS to obtain UV spectra of unprecedented-quality of 10 carefully chosen, bright solar metallicity PNe spanning a broad range in progenitor mass. Line strength measurements of important emission lines of C, N, and O such as OIII] 1660-6, NIII] 1747-54, CIII] 1907-9, and (when He++ is strong) CIV] 1550 and OIV] 1400 in each object will be used along with our own in-house abundance software to determine ion and element abundances for these three species. In turn, these results will be used to assess stellar yields (productivity rates) available in the literature. Favored yield sets will be used to calculate our own chemical evolution models in order to assess directly the importance of intermediate-mass stars in the cosmic evolution of C.
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Proposal Category: GO
Scientific Category: SOLAR SYSTEM
ID: 12601
Title: HST STIS/ACS observations of the aurorae of Uranus during active solar wind conditions
PI: Laurent Lamy
PI Institution: Observatoire de Paris - Section de Meudon

The UV aurorae of Uranus, suspected in IUE observations (1982-1986), were only unambiguously identified during the Voyager 2 flyby (1986). Their peculiar properties relate to the atypical magnetosphere of Uranus, which is characteristic of ice giants. In contrast with the solstice configuration prevailing in the 1980s, that only allowed the northern magnetic pole to be visible from Earth, the situation is now radically different and near-equinoctial conditions allow views of both northern (N) and southern (S) poles transiting across the visible disc, implying a dynamic magnetospheric configuration that has never been studied. We therefore propose to re-attempt to observe the UV aurorae of Uranus with HST spectroscopic (STIS) and imaging (ACS) measurements. We will maximize the probability of detection by scheduling observations of Uranus during a solar wind shock interaction, known to activate auroral activity at other planets. Observations will be distributed over 14 days, centered on the predicted arrival time, and sampling all longitudes. They will characterize the UV aurorae, determine their brightness (and infer the energy of precipitating electrons), their location and their temporal variability up to half a solar rotation. Importantly, it will also permit us to retrieve the rotational phase of the planet and update the rotation period (17.24h). Observations during an interplanetary shock and comparisons with Voyager 2 and previous unsucessful HST observations will finally provide the first insights into the sun/magnetosphere interaction, and highlight its difference with the interaction at the other known

magnetospheres.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12602
Title: Beyond the Hydrogen-burning limit: Deep IR observations of the Globular Clusters M4 and NGC6397
PI: Andrea Dieball
PI Institution: University of Southampton

We propose to use ultra-deep near-infrared imaging with WFC3 in M4 and NGC6397 to explore the very lowest mass domain in these globular star clusters. We expect to detect the first Brown Dwarfs in Globular Clusters, and in fact perhaps the first PopII BDs anywhere. In doing so, we will also explore the hydrogen-burning limit at different (low) metallicities and determine the mass-luminosity relationship around the stellar/sub-stellar border of the main sequence (MS). In addition we will search the cluster white dwarfs for evidence of infrared excess which could herald the presence of a planetary disk or planets themselves. This ultra-deep near-IR data set will allow us to test fundamental physical predictions quantitatively for the first time. This will have important consequences for many astrophysical aspects from stellar structure and evolution, to planet formation in the early Universe, to ages, formation and evolution of GCs.
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Proposal Category: GO
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12603
Title: Understanding the Gas Cycle in Galaxies: Probing the Circumgalactic Medium
PI: Timothy Heckman
PI Institution: The Johns Hopkins University

The greatest impediment to understanding the formation and evolution of galaxies is our ignorance about the cycling of gas into, through, and out of galaxies. To address these issues we are undertaking an ambitious program (GASS – the GALEX Arecibo SDSS Survey) to investigate the atomic, molecular, and ionized gas in the disks of ~350 local galaxies and to determine the relationship of this gas to the star-formation histories of the galaxies. The missing link is information about gas in the circum-galactic medium (CGM) that is believed to be both the repository of the inflowing gas and the receptacle of the feedback of energy and metals generated inside the galaxy. The CGM consists primarily of gas in the temperature range from ten thousand to a million K and is most effectively studied in absorption using background QSOs. In this proposal we are requesting 119 HST orbits so that high-quality COS G130M spectra will be available for all 52 GASS galaxy-QSO pairs in which a suitably bright background QSO probes a sightline within ~250 kpc (~virial radius) of the galaxy. Our goal is to directly connect the presence and properties of the gas in the CGM to the presence and properties of the HI in the galaxy and to the star formation history of the galaxy. In so doing we will test current theories on the formation and evolution of galaxies and provide a unique legacy data set combining these HST spectra with over 1500 hours worth of data from the largest cm- and mm-wave telescopes in the world. The power of this combination of information would be unmatched.
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Proposal Category: GO
Scientific Category: ISM AND CIRCUMSTELLAR MATTER
ID: 12604
Title: Ionization in the Magellanic Stream: A Case Study of Galactic Accretion
PI: Andrew Fox
PI Institution: University of Cambridge

Gaseous inflow plays an important role in spiral galaxy evolution, bringing in the fuel that powers new cycles of star formation. But does the gas come in cold, warm, or hot? Are most infalling clouds destroyed by evaporating into the hot corona? To address these poorly-understood processes, we propose a 20-orbit HST/COS study of the Magellanic Stream (MS), the best known example of gaseous accretion, which shows clear signs of a disruptive interaction with the corona. The MS will be detected in a wide range of low-ion and high-ion absorption lines in the COS spectra of 8 background AGN, each sampling a different region of the Stream. Combining with existing observations from FUSE, VLT/UVES, the Green Bank Telescope (H I), and the WHAM telescope (H-alpha), we will fully characterize the MS ionization level, by determining the total column density of low-ion and high-ion gas in each sight line. This will allow us to derive the total (neutral+ionized) MS mass and the accretion rate it represents. We will then determine the fate of each region of the Stream, by deriving the evaporation timescale and comparing it to the infall timescale. The data will also allow for a comprehensive study of chemical enrichment and dust content in the MS, thus constraining its history. The proposed observations will provide quantitative information on the physical and chemical state of infalling gas clouds, and will test simulations that predict such clouds are evaporated by their interaction with the hot corona. The high sensitivity of COS and the wide range of lines available in the UV make these HST observations the key to completing our multi-wavelength program.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12605
Title: Advances in Understanding Multiple Stellar Generations in Globular Clusters
PI: Giampaolo Piotto
PI Institution: Universita di Padova

This is a proposal to use WFC3 for striking new advances in the populations of globular clusters (GC). Now that recent work (much of it by our own group) has shattered the 50-year-old belief that each GC represents a single event of star-birth, with a single chemical composition, we propose to exploit the superb UV throughput of WFC3 to split main sequences with an unprecedented fineness, and follow them in all evolutionary sequences, up to the horizontal branch (HB), in a quest to finally solve the long-sought "second parameter". From our vantage point in the midst of these developments, we feel that the present-day situation merits a concentration of efforts on HST UV resources, that, in a few years, will not be available any more. We are therefore proposing to observe two classical second-parameter GC couples (NGC 288/NGC 362 and M3/M13), and three clusters with extreme HB extensions (NGC2808,M80,M15) in F275W/F336W/F438W bands. The main-sequence study will cast particular light on the question of helium enrichment, whereas the clear separation of the more advanced evolutionary sequences (SGB, RGB, HB) will allow us to identify the evolutionary paths of each individual sub-population.

In this way, we shall gather critical information capable of shedding fresh light on the sequence of events that have been responsible for the subsequent formation of the various sub-populations.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12606
Title: Verifying the White Dwarf Mass-Radius relation with Sirius B and other resolved Sirius-like systems
PI: Martin Barstow
PI Institution: University of Leicester

White dwarfs (WDs) are the remnants of all stars with initial masses less than 8Msun, and they provide important laboratories for the study of evolutionary processes and the behaviour of matter at extremes of temperature and density. Knowledge of the WD ages is also important in measuring the ages of stellar populations. However, such results depend on a thorough understanding of the evolution of WDs themselves and on predictions of the cooling rates. In turn, the masses, radii, and photospheric compositions affect these rates. We propose STIS observations of a sample of white dwarfs in resolved binary systems, for which Sirius B is the prototype, to obtain Balmer line profiles from which we can measure the effective temperature and surface gravity of each star. In addition, we will obtain an accurate radial velocity from the cores of the Halpha lines. These observations will provide improved fundamental information for each white dwarf yielding: a) the gravitational redshift and b) the optical flux normalization. Together these data will provide accurate mass and radius determinations. For Sirius B, in particular, it means the uncertainty in the spectroscopic mass will be on a par with that of the astrometric mass. By reducing the uncertainties in the V magnitude, log g and gravitational redshift to our expected levels, we find that spectroscopic mass and radius uncertainties will be respectively reduced to 3% and 1.6%. At these levels we can precisely test the theoretical M-R for the white dwarfs, distinguishing between a thick or thin H layer for the star and categorically rule out non-C/O core compositions.
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Proposal Category: GO
Scientific Category: SOLAR SYSTEM
ID: 12607
Title: Using Hubble to Measure Volatile Abundances and the D/H Ratio in a Bright ToO Comet
PI: Harold Weaver
PI Institution: The Johns Hopkins University Applied Physics Laboratory

We propose a 10-orbit program to observe any newly discovered bright comet as a non-disruptive Target of Opportunity during cycle 19. For a comet whose water production rate meets our basic ToO selection criterion, Hubble observations can be used to measure abundances of three highly volatile species (CO, CO2, and S2), providing critical information on the origin and evolution of the comet's nucleus. If the comet additionally has geocentric and heliocentric radial velocities in a favorable range, our Hubble observations will measure atomic deuterium emission, from which we can derive the D/H ratio for comparison to the values measured in other comets and Earth's water. The D/H ratio in cometary water is a key indicator of the role played by comets in the delivery of volatiles to the terrestrial planets. It has been 7 years since a bright comet has been available for Hubble

observations, and the statistics suggest we are overdue for another opportunity.
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Proposal Category: GO
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12608
Title: Small-scale Morphology and Continuum Colors of Giant Lya Nebulae
PI: Moire Prescott
PI Institution: University of California - Santa Barbara

The power mechanism responsible for giant Lya nebulae is a subject of intense debate. These enormous (~100 kpc) and extremely luminous (L_Lya~1E44 erg/s) systems are thought to be regions of ongoing massive galaxy formation. A number of physical mechanisms have been investigated, but observational studies have thus far been unable to unambiguously pinpoint the underlying power source in these rare systems. Up until now, one important aspect of Lya nebulae has yet to be fully explored: namely, the small-scale (sub-kpc) morphology and properties of the spatially extended UV continuum light. The morphology and color of this diffuse continuum provides a complementary means for discriminating between competing ionization scenarios --- spatially extended star formation, AGN scattered light, and gravitational cooling --- but most of the well-studied Lya nebulae lie at redshifts beyond 3 where the crucial constraint on the region of the Balmer break is difficult to obtain and existing low spatial resolution observations from the ground suffer from contamination by compact sources within these complex systems. We propose to image a new sample of systematically selected ``low'' redshift (z<2.5) Lya nebulae using ACS and WFC3 in order to disentangle the diffuse and compact continuum components in these complex sources, provide the first spatially resolved, uncontaminated measurements the color of this diffuse continuum component, assess the evolutionary state of the galaxies within the nebula, and put new constraints on the power source responsible for giant Lya nebulae.
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Proposal Category: GO
Scientific Category: ISM IN EXTERNAL GALAXIES
ID: 12609
Title: Imaging the Distribution of Iron in SN 1885 in M31
PI: Robert Fesen
PI Institution: Dartmouth College

Type Ia supernovae are the thermonuclear explosions of CO white dwarfs but we don't know the specifics of how the nuclear burning proceeds from the core outward once it starts. The thermonuclear instability is thought to start off as a subsonic turbulent deflagration wave but then transition into a supersonic detonation wave. While Ni-56 mass differences between normal and subluminous Type Ia SNe reflect differences in the amount of burning that has occurred, we don't know if the explosion begins at the very center or off-center as some recent models suggest. Directly imaging the chemical distribution of ejecta from a Type Ia SN is actually possible in the case of the subluminous Type Ia SN 1885 which occurred on the near-side of M31's central bulge. The entire 126 year old remnant -- from core to the outer edge -- is visible via strong Ca and Fe line absorptions. In Cycle 17, we imaged the remnant in Fe I using ACS/WFC which revealed a strongly off-center Fe I distribution. However, the dominant ionization species of the remnant's iron-rich ejecta is Fe II, not Fe I. Here we propose a WFC3/F225W Fe II image of

SN 1885 to obtain a high-resolution 2D map of all its iron-rich ejecta by taking advantage of an extraordinary situation: Having a young, nearby Type Ia SN remnant visible in silhouette against a galaxy-size light table -- plus a NUV WFC3 filter (F225W) that isolates the strong resonance lines of Fe II. The proposed observation will reveal the remnant's total iron distribution and sphericity as a function of expansion velocity directly testing SN Ia models with a 2D ejecta mapping.
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Proposal Category: GO
Scientific Category: COOL STARS
ID: 12610
Title: Convection and mass loss through the chromosphere of Betelgeuse
PI: Stephen Ridgway
PI Institution: National Optical Astronomy Observatory, AURA

Betelgeuse is well suited for detailed study of the mass loss process in a massive red supergiant. We have engaged in a multi-scale, multi-color study to trace the ejected material from the photosphere to the interstellar medium, and understand its chemical evolution (formation of molecules and dust). Infrared interferometry already gave us a detailed image of the photosphere, compatible with large convective cells. Adaptive optics spectro-imaging (1.0-2.2 microns) allowed us to detect the presence of the CN molecule and mass loss plume structures up to at least 6 R*. At larger distances, we observed silicate-rich dust in thermal IR (8-20 microns). From the surface to 100 R*, we therefore have a continuous coverage with multicolor imagery. The chromosphere lies at a key location, between the photosphere and the molecular envelope. As shown by STIS spatially resolved spectroscopy (Lobel & Dupree 2001), it contains rising and falling gases. Such structure is supported by our 3D modeling of the convection. In order to probe the dynamics of the envelope and its relation to photospheric spots and mass loss plumes, we propose to obtain UV imaging with STIS at 3 epochs to complement our coordinated ground-based effort as well as the earlier HST UV snapshots. We will use this imagery to correlate structures at different radii and temperatures, and to explore the time-scales of evolution. With the support of our 3D models, this information will answer specific questions including deciding between convective and polar explanations for bright spots and plumes. Our infrared imaging observations will be repeated contemporaneously with the requested HST/STIS images.
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Proposal Category: GO
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12611
Title: Weighing the Low Mass Central Black Hole in NGC404
PI: Anil Seth
PI Institution: Smithsonian Institution Astrophysical Observatory

The lowest mass black holes occupying galaxy centers are important for understanding the form and causes of the scaling relationship between galaxy and black hole mass. We propose to make the first robust dynamical determination of a central BH with mass below a million solar masses using HST/STIS and WFC3 imaging of the nearby galaxy NGC404. Accretion signatures in this system, including a recent detection of a hard X-ray component, provide strong evidence for the presence of a massive black hole. Using dynamical modeling of high-quality adaptive optics integral field kinematics

from Gemini/NIFS, we have derived a firm upper limit of 1 million solar on the mass of this black hole. However, our current dynamical mass estimates are limited by likely spatial variations in the stellar mass-to-light ratio of the galaxy within the central arcsecond. With the proposed STIS spectroscopy and WFC3 imaging, we will make precision measurements of the mass-to-light ratio to create a stellar mass profile at 0.1" resolution. This mass profile will be combined with the existing kinematic data of both stars and gas to cleanly measure the mass of the black hole. NGC404 is the nearest S0 galaxy and presents a unique opportunity to dynamically measure a sub-million solar mass black hole with currently available instrumentation.

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Proposal Category: GO
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12612
Title: Probing Weak Intergalactic Absorption with Flaring Blazar Spectra
PI: John Stocke
PI Institution: University of Colorado at Boulder

We propose to exploit the flaring states of high- and unknown-redshift blazars to obtain very high S/N > 25 COS spectra in order to study details of the local intergalactic medium (IGM) not accessible for study using the plethora of lower S/N data being obtained. Only with very high S/N spectra is it possible to detect the weakest Ly alpha and metal lines wherein may lie a substantial portion of the cosmic baryons. The numbers of weak OVI absorbers can discriminate between collisionally ionized and photoionized models, as well as determine which of several galactic outflow models best matches the IGM metal enrichment. Most importantly, high S/N spectra plus the featureless UV power-law continuum of blazars facilitates the detection of broad, shallow absorbers ["broad Ly alpha" (BLA) and broad OVI-only absorbers] which uniquely probe the T = 3 x 10^5 - 3 x 10^6 K range in the IGM where many cosmic baryons are predicted to be "hiding." In addition, these same spectra will be used to obtain lower limits on, or estimates of, the redshift for any featureless blazars observed using the foreground Ly-alpha forest absorbers. In some cases weak Lyman alpha emission may also be detected, as was recently discovered for a few well-known low-redshift BL Lac objects using COS spectra. We request up to three *non-disruptive ToOs* to carry out this program in Cycle 19. Ground-based monitoring will select objects flaring to V ~ 13.5 mag for HST observations, out of a set of about 30 monitored blazars.

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Proposal Category: SNAP
Scientific Category: AGN/QUASARS
ID: 12613
Title: Are major galaxy mergers a significant mechanism to trigger massive black hole growth at z=2?
PI: Knud Jahnke
PI Institution: Max-Planck-Institut fur Astronomie, Heidelberg

We propose to test the common and plausible, but empirically unsupported assumption that black hole accretion in luminous quasars is triggered by major, gas-rich mergers. We have already shown with the aid of ACS imaging that at recent times, since z~1, there is no evidence for triggering of nuclear activity being dominated by merging. Crucially, with the arrival of WFC3, such a test has now also become possible at the peak of black hole growth (at z~2), where the mode of accretion may well be different and,

indeed, related to merger events. We will obtain WFC3/IR SNAPshot observations of ~45 high-mass quasars at z~2 with luminosities that dominate the luminosity function and, hence, black hole growth. Careful subtraction of nuclear point source contributions will allow us to distinguish the morphological properties of the host galaxies and identify merger signatures. The inferred major merger fraction will then be compared to the major merger fraction in a sample of 150 galaxies without active nucleus but that are similar in mass and redshift, and analyzed in a fully analogous manner. This comparison sample will be constructed from the currently ongoing and already partially completed multi-cycle treasury program CANDELS. From the sample sizes and the demonstrated ability to identify major mergers in WFC3 imaging, even in the presence of a dominating nuclear light source, it follows that we will determine at the 95% confidence level whether luminous quasars have an increased merger fraction by at least a factor two and, hence, whether at z~2 major mergers play a significant role in black hole accretion.
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Proposal Category: GO
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12614
Title: Are the Ultra-Compact High-Velocity Clouds Minihalos? Constraints from Quasar Absorption Lines
PI: Orly Gnat
PI Institution: California Institute of Technology

We propose spectroscopic metal absorption-line observations (C II 1334.5A, Si III 1260.4A, and Si III 1206.5A) of two ultra-compact 21cm H I Arecibo sources, toward two closely aligned (4 and 10 arcmin) and suitably bright (41 and 291 microJy in the FUV) background SDSS quasars that we have identified for this purpose. These ultra-compact H I clouds have been proposed as possible 21cm-selected minihalos in the Local Group. COS measurements will constrain the metallicity and thermal pressures in these possibly multiphased clouds, and will provide a test of the minihalo hypothesis. We request 23 orbits.
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Proposal Category: GO
Scientific Category: HOT STARS
ID: 12615
Title: Weighing the most luminous main-sequence star in the Galaxy
PI: Olivier Schnurr
PI Institution: Astrophysikalisches Institut Potsdam

It is believed that the most massive stars do not exceed ~150 Msol initially, as was derived from the observed cut-off of the initial-mass function (IMF) of the Arches cluster, the most massive, unevolved cluster in the Milky Way. However, recent results by Crowther et al. suggest that the cut-off occurs more likely around 300 Msol. A crucial role in their study plays NGC3603, the most massive, visible, Galactic starburst cluster, that harbors three stars with initial masses higher than any of the Arches stars. However, these findings rely entirely on A1, a binary whose components have very ill-constrained masses, 116 +/- 31 Msol and 89 +/- 16 Msol, respectively. While Crowther et al.'s conclusion thus are possibly wrong, A1 is the only known double-eclipsing system whose components potentially have masses >100 Msol, and whose nearly complete set of orbital and stellar parameters can be derived essentially model-independently. We therefore propose to use HST/STIS to

obtain, for the first time, repeated, high-quality, far-ultraviolet and optical spectroscopy and photometry, to fully constrain, in the most self-consistent manner possible, masses, temperatures, radii, luminosities and distance of A1, with an accuracy of ~5-10%. Both components of A1 will be modeled using the latest atmosphere and evolutionary codes, to calibrate the mass-luminosity relation in the highest mass regime currently accessible to direct observations. Our study will also settle whether the Arches is suited to investigate the upper end, any putative cut-off, of the IMF, with far-reaching consequence for our understanding of massive-star formation.
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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12616
Title: Near-IR Imaging of the Most Distant Spectroscopically-Confirmed Galaxies in the Subaru Deep Field
PI: Linhua Jiang
PI Institution: Arizona State University

The last decade saw great progress in our understanding of the distant Universe as a number of objects at z > 6 were discovered. In particular, with the power of the HST WFC3/IR camera, galaxies and galaxy candidates at z > 6 (up to 10) are being routinely found. However, we still know very little about their physical properties due to a lack of a large and bright galaxy sample with secure redshifts. Here we propose to carry out HST/WFC3 near-IR imaging of a large sample of spectroscopically-confirmed galaxies at 5.7 < z < 7 in the Subaru Deep Field (SDF). SDF is unique: it covers more than 800 sq arcmin; it has the deepest optical images among all ground-based imaging data; it has the largest sample of spectroscopically-confirmed galaxies at z >= 6 so far; it also has deep IRAC (~6 hours) coverage from our Spitzer programs. From the proposed observations and our previous HST programs, we will obtain high-quality near-IR data (rest-frame UV) for about 60 galaxies. The near-IR data is the key to measure the properties of young stellar populations, while the IRAC data constrains mature populations. Using SED modeling with spectroscopic redshifts, we will be able to fully characterize the physical properties of these galaxies and obtain accurate information of age and stellar mass etc. We will also address the physical difference or similarity between Lyman alpha emitters and Lyman break galaxies at z >= 6. All these help us to understand the earliest galaxy formation and evolution and the galaxy contribution to cosmic reionization. Our WFC3 data will enable many other sciences, such as galaxy morphology at z >= 6 and search of bright galaxies at z > 7.
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Proposal Category: AR
Scientific Category: HOT STARS
ID: 12617
Title: Fine Guidance Sensor Parallaxes for Four Classical Novae
PI: Thomas Harrison
PI Institution: New Mexico State University

Classical novae (CN) result from a thermonuclear runaway on a white dwarf and produce the second most violent stellar eruptions in the Galaxy. While we have made considerable progress on understanding the outbursts of these systems, numerous issues remain. We now have a general idea of what drives the peak luminosity of the outburst and the speed at which the CN declines from maximum (white dwarf mass), but we have yet to properly calorimeter these outbursts due to the lack of precise distance information. More importantly, however, is

understanding the mass lost during an eruption (could they be the progenitors of Type I supernovae?). To quantify this, we need to know the volume and filling factor of their ejected shells. This requires accurate distance information, as CN produce clumpy, prolate shells. Four CN have archival FGS data (from 40 orbits
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Proposal Category: AR
Scientific Category: HOT STARS
ID: 12618
Title: Reconstructing the outburst history of Eta Carinae from WFPC2 proper motions
PI: Nathan Smith
PI Institution: University of Arizona

The HST archive contains several epochs of WFPC2 images of the nebula around Eta Carinae taken over a 15-year timespan, although only the earliest few years of data have been analyzed and published. The fact that all these images were taken with the same instrument, with the same pixel sampling and field distortion, makes them an invaluable resource for accurately measuring the expanding ejecta. So far, analysis of a subset of the data (with only a few year baseline) has shown that Eta Car's nebula was ejected around the time of the Great Eruption in the 1840s, but the full 15-yr dataset has much greater untapped potential. Historical data show multiple peaks in the light curve during the 1840s eruption, possibly the result of violent stellar collisions in the eccentric binary system. Proper motions with the full 15-yr dataset will definitively show if one of these is associated with the main mass ejection. Older material outside the main bipolar nebula traces previous major outbursts of the star with no recorded historical observations. We propose an ambitious reduction and analysis of the complete WFPC2 imaging dataset of Eta Car. These data can reconstruct its violent mass-loss history over the past several thousand years. This will constrain the behavior and timescale of eruptive mass loss in pre-SN evolution. The existence of several epochs over a long timespan will date older parts of the nebula that have not yet been measured, and can even measure the deceleration of the ejecta for the first time, essential for understanding their shaping and shock excitation during the nebula's continuing hydrodynamic evolution.
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Proposal Category: AR
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12619
Title: Placing Observational Constraints on Massive Star Models
PI: Philip Rosenfield
PI Institution: University of Washington

The lives and deaths of massive stars are intricately linked to the evolution of galaxies. Yet, despite their integral importance to understanding galaxy evolution, models of massive stars are inconsistent with observations. These uncertainties can be traced to limited observational constraints available for improving massive star models. A sensitive test of the underlying physics of massive stars, e.g., convection, rotation, and mass loss is to measure the ratio of blue core helium burning stars (BHeB) to red core helium burning stars (RHeB), 5-20Msun stars in the stage evolution immediately following the main sequence. Even the most sophisticated models cannot accurately predict the observed ratio over a range of metallicities, suggesting an insufficient understanding of the underlying physics. However, observational measurements

of this ratio over a wide range of environments would provide substantial constraints on the physical parameters governing the evolution of all stars >5 Msun. We propose to place stringent observational constraints on the physics of massive star evolution by uniformly measuring the B/R HeB ratio in a wide range of galaxies. The HST archive contains high quality optical imaging of resolved stellar populations of dozens of nearby galaxies. From the ANGST program, we identified 38 galaxies, spanning ~2 dex in metallicity that have significant BHeB and RHeB populations. Using this sample, we will empirically characterize the colors of the BHeB and RHeB sequences as a function of luminosity and metallicity, measure the B/R ratio, and constrain the lifetimes of the BHeB and RHeBs in the Padova stellar evolution models and the Cambridge STARS code.
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Proposal Category: AR
Scientific Category: SOLAR SYSTEM
ID: 12620
Title: Trans-neptunian Objects in WFC3 archival fields
PI: Cesar Fuentes
PI Institution: Northern Arizona University

We propose to continue our successful archival program by harvesting TNOs (Trans-neptunian Objects) from WFC3 data. We will discover ~100 new TNOs down to 10 km. This will allow us to measure the magnitude distribution for the dynamically hot and cold subclasses independently, probing their potentially different evolutionary histories. We will measure the V-NIR colors for ~30 faint TNOs. This will allow us to test whether TNO surface colors are collisionally-derived (if all small TNOs have neutral/blue colors) or compositionally intrinsic (a range of colors for these smallest TNOs). This proposed work builds on our previous archive program in which we have discovered 45 faint TNOs to date in ACS/WFC data. These experiments can only be carried out with archival HST data.
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Proposal Category: AR
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12621
Title: Dissecting the accreting binary populations in nearby spiral galaxies
PI: Andreas Zezas
PI Institution: Smithsonian Institution Astrophysical Observatory

We propose to analyze archival HST WFC3, ACS and WFPC2 data for 5 nearby spiral galaxies (NGC2841, M83, NGC7793, NGC3621 and NGC4631) which are part of the X-SINGS survey (a Chandra Large Project to follow up the Spitzer Infrared Nearby Galaxy Survey sample). The goals of the project are: (a) to identify the optical counterparts of the X-ray sources in these galaxies; (b) determine their recent star-formation history and (c) study their star-cluster populations. This will allow us to address the nature of the accreting sources, and their connection with star-formation and star-cluster properties. These are critical elements for the understanding of X-ray source populations in general and in particular the calibration of accreting-binary population synthesis models. In addition these results will be a great resource for studies of the spatially resolved star-formation history of nearby spiral galaxies.
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Proposal Category: AR
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12622
Title: Measuring the Star Formation History Of Omega Centauri
PI: Daniel Weisz
PI Institution: University of Washington

We propopse to apply the technique of color-magnitude diagram (CMD) fitting to archival HST/ACS and WFC3 imaging of Omega Centauri in order to measure its star formation history (SFH). As the remnant of a captured satellite galaxy, the SFH of Omega Cen will provide key insights into its formation and evolution before and after its incorporation into the Milky Way. The derivation of SFHs from CMD analysis has been well-established in the Local Group and nearby galaxies, but has never been applied within our Galaxy. Archival HST imaging of Omega Cen provides for exquisitely deep CMDs with broad wavelength coverage (near-UV through I-band), which allows for clear separation of age-sensitive CMD features, and can be leveraged to highly constrain its star formation rate as a function of time. In addition, the CMD fitting technique also allows us to test for consistency in recovered SFHs using different stellar models, and quantitatively tie the UV characteristics of ancient stellar populations to a SFH.
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Proposal Category: AR
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12623
Title: The Local Environments of Supernovae from Archival HST Images
PI: Alex Filippenko
PI Institution: University of California - Berkeley

The locations of supernovae (SNe) in the local stellar and gaseous environment in galaxies, as measured in high spatial resolution WFPC2, ACS, and WFC3 images, contain important clues to their progenitor stars. They provide accurate determinations of any association of SNe with HII regions or star clusters. Since multi-filter observations are generally available, we can assess the local stellar population, setting constraints on the mass of the progenitor; we can also search for possible attenuation of the SN by dust in the host galaxy by studying the colors of the stars in its environment. By checking the fields for background sources, we can correct the existing SN light curves and luminosities if necessary. When a SN has been observed incidentally, information can be gained on its optical and UV emission. Deep HST images can be used to find light echoes of SNe, as well as recover SNe interacting with circumstellar material at very late times. A direct search for the progenitor stars of SNe can be made in pre-existing HST images of their locations; as the number of archival HST images steadily increases, along with the number of newly discovered SNe, positive identifications become progressively more likely. In Cycle 19, we plan to extend our successful work from previous cycles. This proposal is complementary to our Cycle 19 snapshot proposal, whose primary purpose is to obtain late-time photometry of SNe. It is also complementary to our Cycle 19 ToO proposal, which is largely designed to pinpoint the locations of new SNe to help determine their progenitor stars.
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Proposal Category: AR
Scientific Category: SOLAR SYSTEM
ID: 12624

Title: Tracking Titan's Circulation
PI: Caitlin Griffith
PI Institution: University of Arizona

The Cassini Mission is limited by its finite (albeit long) duration (2004 to 2017), which covers half of Titan's 29.5 year orbit about the Sun. Here we propose to analyze STIS spectral images to enhance the return of the Cassini Mission, by extending measurements of the distribution of Titan's haze 7 years prior to the beginning of the Cassini Mission. Titan's haze drifts with the seasons from the summer to the winter hemisphere, tracing the moon's circulation, and also partly establishes the circulation, by absorbing 40% of the incident insolation. This work constrains the northern and southern circulation at the same season, which is not possible from the 1/2 Titan year sampling by Cassini. We will determine the effects of the differential warming of Titan's south and north polar regions that results from the eccentricity of Titan's orbit (e=0.054), which places Titan 11% closer to the Sun near South Summer Solstice (e.g. in 2003). We will release corrected STIS images and density maps of Titan's haze for the community. We will study the consequent difference in the circulation, seasons and weather in the north and south polar regions, and investigate whether the prevalence of Titan's lakes at high northern latitudes, results ultimately from this differential heating.
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Proposal Category: AR
Scientific Category: COSMOLOGY
ID: 12625
Title: The Co-Evolution of Black Holes and Their Host Galaxies
PI: Vardha Bennert
PI Institution: University of California - Santa Barbara

Active Galactic Nuclei (AGNs) are thought to represent an integral phase in the formation and evolution of galaxies during which the central supermassive black hole (BH) is growing through accretion. The tight empirical relations between BH mass and the global properties of the host galaxy spheroid discovered in the local Universe have been explained by a combination of AGN feedback and hierarchical assembly of BH and stellar mass through galaxy merging. A number of groups (including ourselves) have studied the evolution with redshift of the BH mass scaling relations, revealing evidence that BH growth precedes spheroid assembly. However, this tantalizing result is highly uncertain because it is based on small samples at high redshift and dominated by systematic uncertainties when comparing UV luminosities at z~1-2 with those in the local Universe. We propose to take a major step forward, by taking advantage of the virtues of GOODS for a large sample of ~55 AGN hosts with $1<z<2$, allowing us to determine for the first time offset and intrinsic scatter of the BH mass-spheroid stellar mass relation. The multi-filter data coupled with our novel joint multiwavelength analysis technique will be equivalent to a ten-fold increase in quality over existing studies allowing us to determine stellar mass of the host bulge and disk component. The use of stellar masses will eliminate the need for uncertain luminosity-evolution corrections and allow us to measure directly the evolution of the correlations. We can thus test the hypothesis that the evolution is driven by disks being transformed into bulges by mergers or secular processes.
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Proposal Category: AR
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12626

Title: Understanding Stellar Velocity Dispersion in Dusty and Dynamically Non-Quiescent Galaxies
PI: Gabriela Canalizo
PI Institution: University of California - Riverside

When measuring the stellar velocity dispersion of a spheroid, one is actually measuring a flux-weighted line-of-sight velocity dispersion along a single sight-line during a single epoch in the galaxy's evolution. The effect of dust extinction on this flux-weighted measurement is unclear. Furthermore, it is not always clear whether the galaxy being observed is fully dynamically relaxed. If the galaxy is not in a completely quiescent state--due to a recent interaction--the velocity dispersion may be evolving. It is not known how significantly nor how rapidly the velocity dispersion fluctuates during interactions such as mergers. Knowledge regarding the anisotropy of the velocity dispersion tensor is also lacking for such systems. We propose performing the simulations necessary to properly contextualize observations of dusty and non-quiescent galaxies. This will allow observers to better understand measurements of central stellar velocity dispersion in the spheroidal component of galaxies. Any project in which central stellar velocity dispersion is measured will potentially be affected by this work (e.g. GO-10216 and GO-11208). In the proposed research, we will obtain high time-resolution data regarding the evolution of stellar velocity dispersion during numerical simulations of galaxy mergers. In order to include the effects of dust-extinction, we will measure velocity dispersion using a flux-weighting method that is consistent with the observational technique. For this task, the latest version of the radiative transfer code, Sunrise, will be used to create images and Doppler-broadened spectra of the simulated galaxies.
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Proposal Category: AR
Scientific Category: STAR FORMATION
ID: 12627
Title: Probing the early evolution of dust grains through detailed YSO models
PI: Erica Rodgers
PI Institution: Space Science Institute

Understanding the evolution of young stellar objects (YSOs) from a protostar to a main-sequence star is key to understanding the origins and evolution of planetary systems. High-resolution polarimetric observations from both NICMOS and ACS of objects known to span the earliest stellar evolutionary phases will be combined with (1) 3-D radiative transfer codes, and (2) a grid of dust grain models, to gain insight into the initial phases of dust grain growth and evolution away from an ISM distribution. Fractional polarization is a strong function of wavelength; therefore by developing detailed models of polarimetric images in the optical and infrared, we can sensitively constrain not only the geometry and optical depth of the scattering medium, but also the grain size distribution. We will study 15 YSOs known to span the earliest stellar evolutionary phases (Class I – Class III) as their circumstellar disks transition from containing primarily small ISM dust grains to larger size grains indicative of protoplanetary disks. Full modeling of this data set will enable us to specifically address the evolution of the small grain distribution as a function of evolutionary state, and the implications of the early evolution of dust grains on planetary formation. We will make our grid of polarization images publicly available, providing a resource to the community to interpret other datasets.
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Proposal Category: AR
Scientific Category: COSMOLOGY
ID: 12628
Title: Cosmological simulations of the formation and evolution of bulges, pseudo bulges and bulgeless galaxies.
PI: Fabio Governato
PI Institution: University of Washington

How do bulgeless galaxies form? What is the evolutionary path of the high z clumpy disks observed by HST? The majority of galaxies in the local Universe do not have classical bulges or consist of a mix of classic and pseudo bulges. These observations are not easily explained within the Lambda CDM scenario, where mergers are ubiquitous at all galaxy masses. We will run cosmological hydro simulations of galaxy formation to study at high resolution the formation and evolution of bulgeless galaxies and of those with bulges and pseudo bulges. We will connect the present day observations of spheroids with those of clumpy, high z disks. We will: - trace the assembly of the disk and spheroidal component to understand the role of merging and secular accretion on the time sequence for the evolution of the two components. - Evaluate the effect of SNae and SMBH energy feedback, on the evolution of the central region of galaxies and the evolution of the low angular momentum gas. We will improve on previous works by: - using an implementation of star formation based on the local abundance of molecular hydrogen - modelling thermal feedback and SN and SMBHs generated outflows that remove low angular momentum gas and create realistic dwarf galaxies - running cosmological simulations to the present time to naturally link high-z galaxies with their present day counterparts - creating realistic artificial photometric and spectral observations in all HST filters.
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Proposal Category: AR
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12629
Title: Restoring the POS mode Astrometric Precision of FGS-1r and a Definitive Velocity Dispersion for M35
PI: George Benedict
PI Institution: University of Texas at Austin

We propose to analyze 9 new orbits of FGS astrometry, secured under calibration proposals GO-12832 and GO-12383. These will be merged with over 180 previous Optical Field Angle Distortion (OFAD) and Long-term Stability orbits to produce a definitive OFAD calibration. On 22 January 2009 the articulating mirror assembly (AMA) of FGS-1r was adjusted to improve the fringe morphology for TRANS mode (fringe scanning) observations. Unfortunately, this improvement to TRANS introduced a significant discontinuity in the POS-mode OFAD calibration. Previously we routinely obtained millisecond of arc (mas) per-observation residuals, yielding typical parallax errors of 0.2 mas and similar precision for exoplanet perturbation orbital parameters. Attempting to bridge the AMA gap with our existing OFAD calibration, we find residuals in excess of 10 mas. If we do not recalibrate FGS-1r, scientific results from over 300 orbits of FGS-1r POS mode astrometry are at risk. This analysis will also result in useful scientific results for our OFAD field, the open Galactic cluster M35. Comparing our newly derived internal motions (from an eighteen year baseline for OFAD proper motions) to radial velocities should result in an accurate distance to M35. Our catalog of >100 stars in the optical wavelength covers a 26’x11’ field. Its average

relative positional error should be better than 0.1 mas and therefore useful to calibrate the distortions of any astrometric device. We request $120,246 to support a rescue of over 300 orbits of FGS astrometry, the generation of a velocity dispersion and distance to M35, and the preparation of a catalog to calibrate future and present astrometric instruments.
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Proposal Category: AR
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12630
Title: Are Dust Grains in Debris Disks Porous Aggregates?
PI: Christine Chen
PI Institution: Space Telescope Science Institute

We propose to conduct an HST archival study of NICMOS coronagraphic polarimetry data for 7 well-studied debris disks that have been spatially resolved in scattered light. We plan to measure the phase function and polarization fraction to (1) characterize the size and porosity of constituent dust grains, (2) determine whether the circumstellar grains are more similar to porous aggregates released from comets or compact grains generated by collisions among asteroids, and (3) search for broad trends in grain properties that are expected based on parent body temperatures and grain dynamics. Since many of the systems are also imaged in thermal emission and possess well-measured SEDs, we also propose to conduct a multi-wavelength analysis to ensure that our conclusions are robust. HST NICMOS polarimetry of spatially resolved debris disks (with well constrained geometries) provides a unqiue opportunity to derive high quality Stokes I, Q, and U maps that will be challenging to surpass from the ground.
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Proposal Category: AR
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12631
Title: Interpreting the Escape of Ionizing Radiation from Galaxies: Results from Simulations
PI: Alyson Brooks
PI Institution: California Institute of Technology

The emission from star forming galaxies appears to be responsible for reionization of the universe at z > 6. In order to reionize the intergalactic medium (IGM) by z = 6, large fractions of ionizing photons must escape from the galaxies which we are now just beginning to detect at 6 < z < 10. Due to the increasing opacity of the IGM, it is difficult to directly measure escaping, photoionizing emission from the Lyman continuum (LyC) at z > 3. Thus, a comparison of observations and models of the escape fraction at z < 3 offers the best test of our understanding of how ionizing radiation escapes from galaxies. At z = 3, roughly 10-25% of galaxies are detected with escaping LyC emission, a rate that might be explained if escaping radiation is anisotropic. However, no such detections have been found in galaxies at lower redshifts. Here we propose to use high resolution N-Body+SPH simulations that resolve the clumpy nature of the ISM all the way to z = 0 to tie the observations together across time. These will be the first simulations to study the escape fraction at z < 2.5. We will quantify the anisotropic escape distribution, it's dependence on viewing angle, and it's duty cycle, for application to understanding a statistical sample of observed galaxies. We will explore the escape fraction as a function of SFR and redshift, to explain the current observations at z < 3. Finally, we will tie the escape fraction

of galaxies to other observables that can be traced at z > 6 to make testable predictions for high z observations.
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Proposal Category: AR
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12632
Title: Modeling the Star Formation Histories and Kinematics of the Magellanic Clouds
PI: Gurtina Besla
PI Institution: Harvard University

One of the most surprising results to come out of HST in recent years is the proper motion measurements of the Large and Small Magellanic Clouds, which indicate that the Magellanic Clouds (MCs) are moving significantly faster than previously believed (Kallivayalil et al. 2006a,b), and may be on their first infall towards the Milky Way (MW) (Besla et al. 2007). Such a drastically different orbital history overturns a paradigm that has existed for decades and is consequently a controversial result. A detailed theoretical study illustrating the compatibility of these measurements with our understanding of the properties (kinematic structure and star formation histories) of the MCs is thus critical to the verification of these measurements and the establishment of HST as a reliable method of determining high precision proper motions. Furthermore, as the closest pair of interacting dwarf galaxies to the MW, detailed comparisons between the observed star formation histories (SFHs) of the MCs and simulations of the star formation induced by tidal encounters between them will provide a theoretical basis for explaining the various SFHs of dwarf galaxies observed by HST in our local volume. Similarly, models of the kinematic evolution of the gaseous and stellar components of the MCs will help to identify the role of dwarf-dwarf interactions to the evolution of dwarf galaxies into different morphological types (dSph vs. dIrr). These studies will be extended to various environments, including groups of galaxies and clusters, and compared to, e.g., ACS surveys of dwarfs in the Virgo and Coma clusters in order to assess the impact of environment on the evolution of dwarf galaxies.
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Proposal Category: AR
Scientific Category: STAR FORMATION
ID: 12633
Title: On the structure and origin of HH jets.
PI: Fabio De Colle
PI Institution: University of California - Santa Cruz

The goal of this proposal is to study the structure and origin of jets from young stellar objects by using HST observations of T Tauri jets. To this end, we propose to use three different but complementary approaches: tomographic reconstruction to recover the jet velocity cross-section, numerical simulations to compare the predictions of jet ejection models with the observations, and a statistical analysis of the data. First, we plan to use standard tomographic reconstruction techniques to derive the cross-section (i.e. perpendicular to the jet axis) velocity and physical parameters (electron density, temperature and ionization fraction) of the jets. This will allow a reliable estimation of mass- and momentum-flux from the central star-disk system, which, together with the cross-sectional velocity constraints, will help to distinguish between different jet ejection models. Second, we will focus our study on understanding recent observations of stellar jets

showing transverse velocity shifts in several emission lines. The origin of these velocity shift is still debated: they can be interpreted as evidence of rotation, or they can be originated by side-to-side asymmetries in the flow or in the ambient medium. To distinguish between these two scenarios, we plan to uncover the origin of transverse velocity shift by a statistical approach based on the presence (or absence) of correlations between the velocity shifts and the degree of asymmetries in the flow. Finally, we will use our adaptive mesh refinement code to compare the observations with a large number of numerical simulations constructed on different jet ejection mechanisms.
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Proposal Category: AR
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12634
Title: New Constraints on Intracluster Light and the Baryon Budget in Massive Galaxy Clusters
PI: Anthony Gonzalez
PI Institution: University of Florida

We propose to use archival data from the CLASH Multicycle Treasury Program to study intracluster light in massive clusters. The primary objectives of this program are (1) to obtain a complete census of stars in both member galaxies and intracluster light within r500 for a representative sample of clusters, and (2) to use the luminosity distribution and colors of the intracluster stellar population to constrain the origin of intracluster light. As demonstrated by our Cycle 16 program on the Bullet Cluster, WFC3 offers a major step forward for studies of diffuse stellar populations, enabling a vast improvement over previous ground-based studies of intracluster light and total baryon content in groups and clusters. We will use the archival CLASH data to quantify the total stellar baryon content in 10 massive clusters and provide the first ever measurement of the evolution of the ICL. A complementary GO proposal targeting groups has been submitted to extend the mass baseline of our stellar baryon census to lower mass.
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Proposal Category: AR
Scientific Category: AGN/QUASARS
ID: 12635
Title: The Complete Velocity Field of the M87 Optical Jet
PI: William Sparks
PI Institution: Space Telescope Science Institute

The jet of M87 remains a pivotal object in our understanding of high-energy processes at the nuclei of galaxies and in radio galaxies. Visible from radio to X-rays, it remains the most easily observed archetypical outflow of relativistic material from a supermassive black hole. By utilizing a time sequence of observations extending over ten years on one instrument, the WFPC-2/PC, and major technical advances in astrometric techniques for HST, we propose to map the complete velocity field of the M87 jet in the optical continuously and over the entire visible jet. With very conservative accuracies of 0.1 pixel, we reach 0.1 c, sufficient to detect even transverse motions in the magnetic helical instability scenario as well as bulk motion of the "slow" components of the outer jet. This will provide the superb data for comparison with theoretical work on the structure and dynamics of the jet and its interaction with the ambient medium. Additionally, we will push the techniques to their limit and strive to achieve an additional factor 10 in velocity precision (which has been done successfully in other astrometric

programs). With such limits, we can measure velocities to about 3000 km/s opening up completely new areas for dynamical and MHD analysis and modeling, including rotary and spiral motions as well as acceleration and deceleration. With continuous coverage and conservative limits we straightforwardly discriminate between motion, variability, “aliasing” and non-uniform motion to provide a powerful new suite of insights into an astrophysically fundamental phenomenon.
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Proposal Category: AR
Scientific Category: COSMOLOGY
ID: 12636
Title: Galaxy Evolution Studies from High Precision Panchromatic Photometry of Hubble and Spitzer Survey Fields
PI: Bahram Mobasher
PI Institution: University of California - Riverside

We propose to construct uniform and self-consistent multi-waveband photometric catalogues for galaxies detected in the HST/ACS galaxy surveys (both field and clusters) with available Spitzer/IRAC imaging data, using the HST and Spitzer archives. Combined with the existing panchromatic images for each of these survey fields, available from ground- and space-based facilities, we then generate high quality Spectral Energy Distributions (SEDs) for individual galaxies, spanning the wavelength range from UV to mid-infrared (0.1-8.0 microns). These photometric data will then be used to measure the photometric redshift, stellar mass, rest-frame flux, star formation rates, dust extinction and spectral type for individual galaxies. The result will be self-consistent and uniform catalogues for each survey, containing all these parameters. The target fields include: GOODS-N, GOODS-S, COSMOS, HUDF, AEGIS and the ACS cluster survey. We use the Template FITting technique (TFIT) to perform consistent multi-waveband photometry on images with widely different resolutions (i.e. PSFs). The result is catalogues with the depth and spatial resolution of the ACS images and consistent (PSF-matched) photometry across the wavelength range. The final catalogues for different surveys (field and clusters) can be securely combined or directly compared. Therefore, it will provide a major resource for research. The catalogues will be provided to the community and the STScI archive with the required documentation and the necessary interface to easily access them. These catalogues will provide the community with the required resources to address the most fundamental scientific questions.
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Proposal Category: AR
Scientific Category: STAR FORMATION
ID: 12637
Title: Fourteen Years of Proper Motions in the HH30 Protostellar Jet
PI: Karl Stapelfeldt
PI Institution: Jet Propulsion Laboratory

HH 30 is an edge-on young stellar object disk with highly collimated emission line jets outflowing along its polar axis. As a prototype of its class (and of astrophysical accretion disks generally), the object has been the subject of extensive study with HST. Thirteen HST programs have imaged on the object at nineteen epochs over the period 1994-2008; thirteen refereed papers have used this data to report on the disk structure, the jet structure, and the outflows from adjacent sources XZ Tauri and HL Tauri. Yet surprisingly, no

comprehensive study has yet been made of the HH 30 jet proper motions treating more than just two epochs of observation. We propose to investigate the kinematics and structural evolution of the HH 30 protostellar jet over all 15 epochs for which there are Archival R band continuum and emssion line images taken by WFPC2 and ACS. We will track the astrometric and morphological evolution of a dozen emission knots in the jet, thereby measuring their velocities, accelerations, expansion, mergers, and luminosity evolution. The results will provide strong constraints for models of the propagation of astrophysical jets with Mach numbers near 20.
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Proposal Category: AR
Scientific Category: AGN/QUASARS
ID: 12638
Title: AGN Hosts at z ~ 2: The Role of Morphology in the Co-Evolution of Black Holes and Galaxies
PI: Claudia Urry
PI Institution: Yale University

We propose to use newly available WFC3/IR data in the CANDELS fields to study AGN and their host galaxies at the peak epoch of supermassive black hole growth. Analysis of AGN+host galaxies probes the nature of the co-evolution of black holes and galaxies; for z > 0.5 this requires high-resolution observations with HST, but ACS optical filters are limited to z < 1.25, beyond which their rest-frame UV wavelengths make determination of host morphologies unfeasible. Near-infrared filters on the WFC3 instrument capture high-resolution rest-frame optical images of galaxies at z ~ 2, when galaxies are rapidly evolving and black holes are rapidly growing. Recent observations of local AGN hosts indicate a correlation between morphology and black hole growth rate; investigation of this correlation in the era where large galaxies are being assembled as their central supermassive black holes are strongly accreting (z ~ 2) has only recently become possible. We propose to create the first ever statistically significant (~ 200 objects) sample of rest-frame optical AGN host galaxy morphologies at this epoch of peak co-evolution of black holes and galaxies. This analysis will additionally produce stellar masses and SEDs of host galaxies and bolometric luminosities of obscured AGN. All analysis products will be made publicly available.
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Proposal Category: AR
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12639
Title: The Corollaries of the Ultra-Compact Nuclear Rings in Disk Galaxies
PI: Isaac Shlosman
PI Institution: University of Kentucky

Some `composite' Seyfert 2 nuclei show evidence for massive ultra-compact starbursts within the central 40-200 pc. When spatially resolved with the HST, these starbursts exhibit morphology similar to `canonical,' 1-2 kpc size, nuclear rings which form as a result of radial gas inflows in barred and (maybe) interacting galaxies. Based on our recent work, although only a few of such Ultra-Compact Nuclear Rings (UCNRs) are known to date, there are reasons to believe that this is the tip of the iceberg. UCNRs can be closely related to both the AGN and starburst activity in the nucleus, and to the host galaxy. They may thus be the missing link between the two. We propose the first comprehensive statistical study of the fraction and properties of such UCNRs

in nearby galaxies using HST archival data. We shall also investigate the UCNR population in matched samples of Seyfert 2s, LINERs, `transition' objects and `pure' nuclear starbursts. The targets will be selected from the homogeneous survey of 486 objects of Ho et al., of which we estimate more than half to have suitable archive data. We shall find the size, ellipticity, color distributions and stellar populations of the UCNRs, explore how they relate to nuclear activity and analyze correlations between UCNR population and global galactic properties. We shall determine whether the UCNRs form a distinct population from the canonical 1-2 kpc size nuclear rings or they constitute the tail distribution of their larger counterparts. The properties of the UCNR population will allow us to distinguish between the various theoretical models of gas flow within the central 40-200 pc, thus providing stringent clues to the fueling mechanisms of AGN and explore any possible linkage between central starbursts and AGN. While we do not expect to provide definitive answers to all of these questions, this will be the first attempt to link observationally and theoretically the AGN processes to those in their host galaxies.
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Proposal Category: AR
Scientific Category: HOT STARS
ID: 12640
Title: Advancing Spectroscopic Analyses of Hot Stars and Supernovae
PI: D. Hillier
PI Institution: University of Pittsburgh

Much of our current knowledge about stars comes from detailed studies of their spectra. However to interpret their spectra requires detailed atmospheric models. To advance the study of the spectra of hot stars (T > 8000K) and supernovae, we will significantly enhance and further develop the radiative transfer code, CMFGEN, which is publicly available at my website (www.pitt.edu/~hillier). This code has been successfully used to model O & B stars, Wolf-Rayet (W-R) stars, Luminous Blue Variables, A supergiants, [W-R] central-stars of planetary nebulae, and supernovae, and has been used to make available to the community theoretical UV fluxes for both O stars and W-R stars. Massive stars play an important role in starbursts and galaxies --- dynamically, energetically, and chemically. Mass loss from massive stars significantly affects the elemental abundance ratios in starbursts and plays a major role in the origin and recycling of the elements in the interstellar medium of galaxies. Massive stars are thought to play a key role in the metal enrichment and reionization of the early Universe, and are also thought to be responsible for one class of gamma-ray bursters. Understanding massive stars, their radiation, their mass-loss rates, and having reliable parameters is thus crucial to many different areas of astrophysics. CMFGEN has made a significant contribution to the analysis of massive stars and supernovae; the proposed enhancements will allow CMFGEN to continue to be an invaluable tool to expand our astrophysical knowledge.
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Proposal Category: AR
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12641
Title: Exploring the Galactic Damped Lyman alpha Absorber with Antipodal Sight Lines
PI: Charles Danforth
PI Institution: University of Colorado at Boulder

Damped Lya Absorbers (DLAs) are the highest column density systems seen in the spectra of distant quasars. Some DLAs are thought to represent absorption from gas associated with an intervening galaxy disks, halo, tidal tail, etc., along the line of sight and DLAs are a key method of studying star formation, metal abundances, and kinematics at high redshift. These systems are exceedingly rare at low-z where the intervening galaxies can be studied in detail, so the precise nature of these important diagnostics remains poorly-understood. However, there is one DLA present along every extragalactic sight line which we can study in exhaustive detail: the Milky Way DLA

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Proposal Category: AR
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12642
Title: The Nature and Origin of Multiple Populations in Magellanic Clouds Stellar Clusters.
PI: Vera Kozhurina-Platais
PI Institution: Space Telescope Science Institute

The discovery of widespread abundance variations in Milky Way Globular Clusters brought renewed interest in their star formation histories. Simulations suggest that the star formation timescale in a globular cluster must be on the order of 100 Myr in most cases and not longer than 500 Myr. This age spread is too small to be detectable in CMDs of ancient globular clusters in the Milky Way, even with HST/ACS. However, many populous, intermediate-age star clusters in the Magellanic Clouds were recently found to possess broadened main sequence turnoffs. This renders these clusters very powerful probes of the history of star formation in star clusters. We propose to derive CMDs from high-precision ePSF fitting photometry, corrected for instrumental imperfections, for 21 Magellanic Cloud star clusters. These CMDs constitute a unique, homogeneous, and statistically significant sample to 1) study cluster formation via the shape of the age distribution and chemical abundance variation; 2) improve our understanding of stellar astrophysics, particularly convective core overshoot and rotation which have important implications for the turnoff stars in these clusters; 3) provide an accurate library of the properties star clusters which will serve as a reference for studies of both resolved and unresolved studies of intermediate age stellar populations. We plan to make the photometry catalogs and stellar models produced for this project publicly available, ensuring our efforts will have a lasting value.

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Proposal Category: AR
Scientific Category: COSMOLOGY
ID: 12643
Title: Probing the Warm-Hot Intergalactic Medium using Weak, Distributed Metal Absorption
PI: Matthew Pieri
PI Institution: University of Colorado at Boulder

The incomplete census of baryons in the low-redshift Universe is one of the outstanding problems of modern cosmology. Up to 50% of baryons are as yet unaccounted for. It is thought that the primary reservoir of missing baryons is the warm-hot intergalactic medium (or WHIM). This gas is thought to be at temperatures $5 < \log T(K) < 7$ mainly due to shock-heating during gravitational collapse. Metal ionization species are an ideal probe of these physical conditions. They may be seen via absorption in UV spectra of quasars. Surveys

are underway to search for these metals by identifying individual absorption lines in COS spectra. We propose to measure the signal of weak, distributed absorption between these lines. In doing so, we expect to probe an equally large portion of the baryon budget as found by these surveys. We intend to achieve this by use of searches for correlated absorption that we have refined ourselves. We propose to use COS spectra that will be in the HST archive before the start of Cycle 19 and supplement this with archival STIS and FUSE spectra. We also propose to search for metal enrichment in galactic voids using the same methods and data.
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Proposal Category: AR
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12644
Title: Archival COS Survey of Analogs of Weak MgII Absorbers in the Present
PI: Jane Charlton
PI Institution: The Pennsylvania State University

Weak MgII absorbers are essential to understand galaxy environments because they trace the processes in the interface between galaxies and the intergalactic medium. These quasar absorption line systems, with a MgII 2796A rest frame equivalent width in the range 0.02 - 0.3 A, have been found to peak in abundance at a redshift of 1.2, and to dominate in number over the strong MgII absorbers that trace primarily low ionization regions in and around galaxies. The surprising thing is that the weak MgII absorbers, despite their locations typically 50-100kpc from luminous galaxies, have metallicities in many cases close to or exceeding the solar value, even at redshifts as high as 2. Our previous STIS archival survey of weak MgII absorbers in the present (redshifts 0 to 0.3) used the similar low ionization SiII(1260) and CII(1335) transitions as tracers, finding six absorbers along 25 sightlines. The COS archive now contains >100 quasar spectra which typically allow detection to more sensitive limits than our previous survey. Thus, we expect to find 25 weak MgII absorbers in the new survey to an equivalent width limit of 0.02A. In addition, we will probe the lower end of the equivalent width distribution to see if there is a turnover. We will now have a large enough sample of low redshift weak MgII absorbers to consider their hypothesized mixed origins in small (tens of parsecs), metal-rich pockets and in larger (kiloparsec scale), lower density clouds that have become less ionized at lower redshifts. This will allow us to explore volumes around galaxies that are populated by high velocity clouds, by satellite galaxies, and by gas ejected in galactic winds.
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Proposal Category: AR
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12645
Title: H I Selected Survey for Damped Lyman alpha systems with z < 1
PI: Arthur Wolfe
PI Institution: University of California - San Diego

We will carry out a survey for damped Lya systems (DLAs) at z<1 with the STIS, FOS, and COS spectroscopic archive of HST. Previously Rao and Turnshek found 41 z~1 DLAs with HST through the pre-selection of systems with strong MgII absorption. These efforts provide the basis for our current knowledge on the distribution and mass of HI gas in galaxies over the past ~10Gyr. However,

MgII pre-selection may suffer from systematic bias. Furthermore, the technique has been primarily limited to z>0.6 and results related to redshift evolution are sensitive to the assumed mapping of MgII to DLAs. With the installment of COS on HST, we shall perform a a survey without pre-selection for DLAs at z<1. This can be performed with the existing dataset of UV spectroscopy. With the proposed funding, our group will establish the observational criteria for such analysis, develop custom software for DLA fitting in the Poisson-limited regime of COS, and perform the first comprehensive, unbiassed survey of DLAs at z<1. We will disseminate our results through publications and with a dedicated website that will be updated to include new observations. We predict the detection of 15-40 new DLAs. Analysis of these systems will constrain the HI frequency distribution for galaxies over the past ~10Gyr and provide a new estimate of the cosmological mass density of neutral gas. Furthermore, the COS data (especially) will yield a sample of 10+ DLAs at z<0.1 for unique, high-fidelity follow-up observations in UV-IR passbands, and 21cm wavelengths. These DLAs will also be used for calibration of the CII* technique for inferring star formation rates in high-z DLAs.
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Proposal Category: AR
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12646
Title: Absorption Line Analysis to Interprete and Constrain Cosmological Simulations of Galaxy Evolution with Feedback
PI: Christopher Churchill
PI Institution: New Mexico State University

The mammoth challenge for contemporary studies of galaxy formation and evolution are to establish detailed models in the cosmological context in which both the few parsec scale physics within galaxies are self-consistently unified and made consistent with the observed universe of galaxies. They key diagnostics reside with the gas physics, which dictate virtually every aspect of galaxy formation and evolution. The small scale physics includes stellar feedback, gas cooling, heating, and advection and the multiphase interstellar medium; the large scale physics includes intergalactic accretion, local merging, effects of supernovae driven winds, and the development of extended metal-enriched gas halos. Absorption line data have historically proven to be (and shall in the future) virtually the most powerful tool for understanding gas physics on all spatial scales over the majority of the age of the universe- the key to success. Simply stated, absorption lines are one of astronomy's most powerful observational windows on the universe (galaxy formation, galaxy winds, IGM metal enrichment, etc.). The high quality and vast numbers of absorption line data (obtained with HST and FUSE) probe a broad range of gas structures (ISM, HVCs, halos, IGM) over the full cosmic span when galaxies are actively evolving. We propose to use LCDM hydrodynamic cosmological simulations employing a Eulerian Gasdynamics plus N-body Adaptive Refinement Tree (ART) code to develop and refine our understanding of stellar feedback physics and its role in governing the gas physics that regulates the evolution of galaxies and the IGM. We aim to substantially progress our understanding of all possible gas phases embedded within and extending far from galaxies. Our methodology is to apply a series of quantitative observational constraints from absorption line systems to better understand extended galaxy halos and the influence of the cosmological environment of the simulated galaxies: (1) galaxy halos [quasar absorption line systems], (2) high-velocity clouds and the disk, halo, and corona gas of the Milky Way, and (3) starburst galaxies and Lyman-break galaxies. Our proposed work promises

to increase the value of existing and future HST observations by providing a theoretical framework on which they can be deeper interpreted and understood.
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Proposal Category: AR
Scientific Category: COSMOLOGY
ID: 12647
Title: Galaxy formation in LCDM: numerical models for CANDELS project
PI: Anatoly Klypin
PI Institution: New Mexico State University

We propose to create a large library of high-resolution cosmological simulations of galaxies forming in the standard LCDM cosmology with the goal to provide theoretical support for the interpretation of HST observations, especially in connection with the Cosmic Assembly Near-IR Deep Extragalactic Legacy Survey (CANDELS), focused on galaxies at z=2-8. The simulations will provide a statistical sample of galaxies in different environments and with different degrees of interaction. Our hydrodynamic plus N-body code ART models numerous physical processes including molecular cooling, radiation pressure due to young stars, feedback due to SNII and SNI, metal enrichment, and fueling of and feedback from AGN. We plan to produce hundreds of simulations of Milky- Way-size galaxies run to redshift different z's with hundreds of additional dwarf and satellites galaxies in surrounding regions. The simulations have extremely high resolution of 20-50 parsec - the best currently available. Using radiative-transfer code SUNRISE we will produce many observable properties of the simulated galaxies, including images in many wavebands including the effects of stellar evolution and dust, SEDs out to the far-IR, star-formation histories, and kinematics. For years, understanding galaxy formation suffered from two big obstacles: lack of data on the underlying "stellar scaffolding" of galaxies beyond z ~ 1 and lack of realistic codes to model early stages of galaxy formation. The WFC3-IR camera is solving the first problem, and now is the right moment to invest in the first extensive realistic suite of hydrodynamic models, without which the precious new data cannot be properly used.
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Proposal Category: AR
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12648
Title: Characterization and Modeling of Mass Segregation and Intermediate-Mass Black Holes in Globular Clusters
PI: Roeland van der Marel
PI Institution: Space Telescope Science Institute

Studies of the dynamics and stellar populations of globular clusters are at the forefront of HST research. These two topics are deeply intertwined. Clusters experience an interplay of collisional processes that drive stars toward energy equipartition, thus segregating more massive stars to the core. In young clusters, this can even lead to the formation of intermediate-mass black holes (IMBHs), which are of great astrophysical interest, although evidence for them continues to be disputed. Our recent HST(-supported) observational and theoretical studies indicate that equipartition in a cluster is not generally attained. Measurement of the actual mass segregation in clusters can yield significant insight into some of the most important cluster parameters, including the mass of any IMBH (which tends to quench mass segregation). We have demonstrated this explictly on archival data of NGC2298

and M10. HST imaging (including parallel fields) exists in fact over large radial ranges for many globular clusters. This trove of information remains largely untapped, as studies generally focus on the cluster core. We propose here to rigorously quantify and model the mass segregation in all 66 Galactic globular clusters with suitable HST data. We will create CMDs, LFs, and MFs as function of radius, and will release the resulting Legacy data products to the community to enable a host of ancillary investigations. We will run N-body models to interpret the observed mass segregation in the sample clusters. Data-model comparisons will constrain the mass of any IMBHs, will identify IMBH-candidates for more targeted follow-up, and will shed new light on cluster structure and evolution.
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Proposal Category: AR
Scientific Category: COOL STARS
ID: 12649
Title: Shy Dimwits: A Search for Cold and Distant Brown Dwarfs in WFC3 Near-Infrared Slitless Grism Archival Data
PI: Adam Burgasser
PI Institution: University of California - San Diego

Low-temperature L- and T-type brown dwarfs are ubiquitous in the vicinity of the Sun, but studies of these objects at large distances have been avoided due to their exceedingly faint luminosities. Nevertheless, a significant sample (roughly 200) of distant and cold brown dwarfs are likely present in the >250 WFC3 slitless G141 grism pointings currently available in the HST archive. I propose an Archival Program to identify and characterize these sources, using empirical templates to determine spectral types and atmospheric parameters (temperature, surface gravity and metallicity). I will then use this sample to constrain the mass function and Galactic spatial distribution of brown dwarfs in thin disk, thick disk and halo populations, extending prior work with HST/WFPC2 and HST/ACS well beyond the hydrogen-burning mass limit. By sampling and spectroscopically characterizing these overlooked distant and cold brown dwarfs, I aim to realize their potential as standard candles and clocks in investigations of the Milky Way.
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Proposal Category: AR
Scientific Category: COSMOLOGY
ID: 12650
Title: Massive Galaxy Clusters at High Redshift: A Challenge to ?CDM or to Cluster Mass Calibration?
PI: Risa Wechsler
PI Institution: Stanford University

The standard cosmological paradigm, LCDM with Gaussian initial conditions, makes specific predictions for the abundance of high mass objects and for the evolution of this abundance with time. The existence of even a few very massive galaxy clusters at high redshift can falsify the model, if a robust connection can be made between the true mass of the systems and their observed properties. Hubble Space Telescope provides a unique opportunity to study the mass distribution of high redshift clusters via weak gravitational lensing. It has been argued that the recent discovery and confirmation, with HST lensing measurements, of a number of massive galaxy clusters at high redshift indicates tension either with the standard LCDM model --- potentially giving evidence for non-Gaussian initial conditions and probing the physics of inflation --- or with our current understanding of the mass calibration.

However, these conclusions are uncertain due both to lack of statistics for theoretical calibration of the LCDM mass function at the highest end and due to uncertainty in the relationship between halo mass and various cluster observables at these redshifts. We propose to use large-volume simulations, probing ~ 2000 Gpc^3, to characterize the statistics of these massive systems at high redshift (z > 1), and to perform high-resolution zoom-in simulations to study the mass calibration for these clusters in detail. These studies are essential to interpret the influx of HST followup of the most massive high redshift clusters detected in the SZ and X-ray, and to confirm or deny evidence for deviations from LCDM from these data.

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Proposal Category: AR
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12651
Title: Anatomy of Starbursts in Extragalactic Giant HII Regions
PI: Jessica Evans
PI Institution: University of Illinois at Urbana - Champaign

Extragalactic giant HII regions (EGHRs) are sites of active, concentrated star formation, and thus provide excellent labs to analyze starburst phenomenon. Although they have been known for a long time, ground-based observations cannot resolve the physical structures and stellar content of EGHRs. The high resolution and sensitivity of Hubble Space Telescope (HST) are ideal for detailed studies of EGHRs. We have searched the Hubble Legacy Archives (HLA) and found 17 nearby galaxies, within ~15 Mpc, with H-alpha and continuum images. We propose to use these images to study the three top-ranking HII regions in each galaxy. While these 51 HII regions span a range in luminosity, most of them are bonafide EGHRs, with H-alpha luminosity greater than a few times 10^39 ergs/s. We will use the H-alpha image to study the distribution and physical structure of the gas in each HII region and determine its H-alpha luminosity and required ionizing flux. We will use the continuum images to determine whether concentrated clusters or distributed OB associations reside in these HII regions, and use photometric measurements to determine the mass and age spread of the resolved stellar population. These will then be compared with the interstellar structures. The results will help us understand the starburst phenomenon and answer questions such as: Are globular clusters formed in EGHRs? How does star formation proceed in an EGHR? How does the physical structure of an EGHR relate to the luminosity, physical location in the host galaxy, and the host galaxy type?

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Proposal Category: AR
Scientific Category: EXTRA-SOLAR PLANETS
ID: 12652
Title: Exoplanet Search in the HST NICMOS coronagraphic archive
PI: Remi soummer
PI Institution: Space Telescope Science Institute

The HST NICMOS coronagraphic archive is a rich repository of data that has not yet been systematically mined for the presence of planets using the most current image processing techniques. Recent improvement in optimal PSF subtraction algorithms, combined with a recent complete recalibration of the NICMOS coronagraphic archive (LAPLACE), enables an order of magnitude improvement in contrast compared to the data processing previously performed. We propose to reprocess a selection of survey-type programs that include interesting targets for potential exoplanet detections. By the end of our

study we will deliver to the community a list of candidates with precise astrometry and photometry so they can be followed up and fully characterized. More importantly our ensemble of non-detection will be gathered in a publicly available database of sensitivity maps spanning a wide range of host star spectral types and ages. This effort will establish a standard framework for such high-level data products, which will contribute to future high-contrast imaging instruments and missions. We believe that this ambitious reprocessing of the archive will further establish the NICMOS' legacy in the field of exoplanetary science.
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Proposal Category: AR
Scientific Category: AGN/QUASARS
ID: 12653
Title: The contribution of quasar outflows to cosmological structure formation
PI: Nahum Arav
PI Institution: Virginia Polytechnic Institute and State University

A vast new discovery space is opened up by the high sensitivity of COS in the far UV. These new capabilities are ushering a revolution in the study of AGN outflows. We now have the ability to obtain high quality data on objects up to a redshift of about 1, providing access to ten times more (and better) diagnostic absorption lines than was possible with STIS (which could only observe outflows at z<0.05 with sufficient S/N). These diagnostics will allow us to quantify how much do quasar outflow contribute to AGN feedback. On the way to this lofty goal, we'll be able to resolve important questions in the study of these outflows: Where are they situated within the host galaxy? What is their ionization equilibrium and chemical abundances? Unlike ground-based observations, COS data can yield the answers to all these questions for the most ubiquitous outflows, and therefore connect them to our developing understanding of cosmological structure formation. Our analysis of recent archived COS observations gives a concrete example for the above claims; including the first determination of the distance from the central source for a high-ionization outflow. Here we propose an archive program to look through the 520 COS G130M and G160M orbits of AGN archive observations, identify quasar outflows and publish the analyses of the best cases.
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Proposal Category: AR
Scientific Category: COSMOLOGY
ID: 12654
Title: Dark Interactions: New Constraints on Self Interacting Dark Matter
PI: Steven Allen
PI Institution: Stanford University

We propose to test the Cold Dark Matter paradigm by measuring the central dark matter ellipticity and density profiles for a sample of 18 massive, dynamically relaxed galaxy clusters. We will detect, or place strict limits on, the presence of isothermal dark matter cores using simultaneous statistical modeling of strong & weak gravitational lensing and X-ray data. These measurements will place strong and robust constraints on self interacting dark matter models. Such constraints, when combined with dark matter annihilation cross section constraints, have the potential to rule out a class of dark matter models commonly used to explain anomalies observed across a number of prominent, current dark matter experiments.

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Proposal Category: AR
Scientific Category: QUASAR ABSORPTION LINES AND IGM
ID: 12655
Title: Detectable UV Absorption-Signatures from the Missing Baryons: Shock Models for Interpreting COS Observations
PI: Orly Gnat
PI Institution: California Institute of Technology

It is a remarkable fact that in the present day universe more than 50% of the baryonic matter is "missing'', in that it has not yet been accounted for observationally. Hydrodynamic simulations of structure formation predict that these baryons may reside in a Warm/Hot Intergalactic Medium (WHIM) with temperatures in the range 1e5-1e7 K. The WHIM is produced by the shock waves that occur as gas falls from the diffuse intergalactic medium onto the dense regions where galaxies form. Detecting signatures from the WHIM is one of the main science drives of the Cosmic Origins Spectrograph (COS). In this proposal I describe a set of theoretical computations of the absorption-line signatures of WHIM shocks, which are crucial to interpreting COS observational data. In particular, I focus on the detectable UV-absorption signatures associated with the radiative precursors of WHIM shocks.
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Proposal Category: AR
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12656
Title: THE ULTIMATE CATALOG OF OMEGA CENTAURI: 15-BAND PHOTOMETRY AND PROPER MOTIONS
PI: Jay Anderson
PI Institution: Space Telescope Science Institute

We propose to construct the most comprehensive catalog of photometry and proper motions ever assembled for a globular cluster (GC). The core of Omega Centauri has been imaged nearly 500 times through WFC3's UVIS and IR channels for the purposes of detector calibration. There exist ~30 exposures through each of 15 filters, stretching uniformly from F225W in the UV to F160W in the infrared. Furthermore, the 8-year baseline between this data and a 2002 ACS survey will more than double the accuracy and triple the number of well-measured stars compared to our previous groundbreaking effort. This totally unprecedented complete spectral coverage for over 300,000 stars, from the red-giant branch (RGB) down to the white dwarfs (WDs), provides the best chance yet to understand the multiple-population phenomenon in any GC. A preliminary analysis of the color-magnitude diagrams in different bands already allows us to identify more than 10 distinct sequences. We will make the full catalog of 15-band photometry and proper motions available to the community within 6 months of starting this project. We will then be the first to exploit this tremendous resource. The science we will address includes: (1) identifying all the sequences and tying them together, from the main sequence up to the RGB; (2) continuing the search for a central massive object; (3) examination of the WD sequence for any manifestations of multiple-populations; and (4) searching for cataclysmic variables and He WDs.
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Proposal Category: AR
Scientific Category: UNRESOLVED STELLAR POPULATIONS AND GALAXY STRUCTURE
ID: 12657

Title: Gravity's Microscope: Probing fine structure of z~1-2 galaxies stretched into arcs by lensing.
PI: Sangeeta Malhotra
PI Institution: Arizona State University

Gravitational lensing does not just brighten galaxies, it stretches them into long arcs providing a great opportunity to analyze star formation and stellar populations in z=1-2 galaxies at unprecedented resolution- especially with HST. (1) We will study the distribution of Star Formation Intensity (i.e. star-formation rate per unit area, hereafter SFI) in well resolved arcs. Lensing conserves the surface brightness of lensed galaxies, even as it magnifies the objects in size and luminosity, allowing us to study the SFI distribution independent of lensing models. Starburst galaxies at redshifts z=0-6.7 show a definite upper limit to the intrinsic SFI independent of redshift. We will test whether this limit also holds at smaller spatial scales. (2) Our next analysis, pixel-to-pixel modelling of Spectral Energy Distributions (SEDs), will yield stellar populations and Star-formation-histories(SFH) of redshift 1-3 galaxies at an unprecedented spatial resolution. Stellar population modelling of z > 1 galaxies reaches 1 Kpc resolution at best, even with HST. Mixing populations at this scale can result in young stars dominating the light. WIth our pixel-to-pixel analysis, we will measure variations of stellar population across the galaxy at resolutions of up to 100 parsecs. In particular, we will quantify old stellar populations better by resolving out and separating young star-forming regions. We will then do SED fitting of the whole arc to calibrate how the analysis of the average light differs from a spatially well resolved analysis.
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Proposal Category: GO
Scientific Category: RESOLVED STELLAR POPULATIONS
ID: 12658
Title: Fundamental Parameters of the SHIELD Galaxies
PI: John Cannon
PI Institution: Macalester College

The "Survey of HI in Extremely Low-mass Dwarfs" ("SHIELD") is an ongoing EVLA multi-configuration study of the neutral ISM of 12 extremely low-mass (HI mass <10 million M_Sun) galaxies discovered by the Arecibo Legacy Fast ALFA (ALFALFA) survey. The SHIELD galaxies are among the lowest-mass gas-rich objects that harbor stellar populations. These systems span the critical mass range that connects the comparatively massive dwarfs of the local universe to the lowest-mass candidate "minihalos" and "Leo-T" type objects. Further, the halos in this dynamical mass range are predicted to differentiate between systems that are readily destroyed and systems with typical baryon fractions. These galaxies thus constitute a cosmologically important, but unexplored, population. We propose a holistic HST imaging study of the fundamental parameters and characteristics of these extremely low-mass galaxies. The primary science goal is the derivation of TRGB distances; the distance dependence of many fundamental parameters makes HST observations critical for the success of SHIELD. Additional science goals include an accurate census of the dark matter contents of these galaxies, a detailed spatial and temporal study of star formation within them, and a characterization of the nature of star formation in local conditions that differ markedly from those found in more massive galaxies. In order to complement our HST observations we also propose coordinated Spitzer imaging that will accurately constrain the total stellar masses of the SHIELD galaxies. This program will explore the stellar populations at the faint end of the HI mass function for the first time.

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Proposal Category: GO
Scientific Category: COSMOLOGY
ID: 12659
Title: Strongly Lensed Dusty Star Forming Galaxies: Probing the Physics of Massive Galaxy Formation
PI: Joaquin Vieira
PI Institution: California Institute of Technology

The South Pole Telescope (SPT) has recently discovered a new population of extraordinarily millimeter-bright objects in a deep, 1300-square-degree survey of the southern sky. Our extensive two-year follow-up campaign to investigate the nature of these objects has demonstrated that they are high-redshift, strongly lensed, dusty, star-forming galaxies (DSFGs). Gravitational lensing magnifies these sources by factors of 10 to 100, providing a unique opportunity to study these objects in greater detail and at lower cost than would otherwise be possible. We propose to obtain two-color WFC3 imaging for a representative sample of 18 SPT sources, all of which have precise positions from millimeter interferometers and deep near-infrared (NIR) imaging with Spitzer/IRAC and/or ground-based facilities. HST imaging is the only way to achieve the angular resolution and sensitivity required to separate NIR emission from the lensed galaxies from the much brighter lenses. These observations are essential to using these objects to probe extreme galaxy formation processes in the early universe---from these data and ground-based redshifts we will construct the lens models needed to determine the intrinsic properties of the sources and the spatial extent of the star formation activity. Only through the unique capabilities of Hubble can we interpret our other observations and fully exploit the magnified view of the early universe afforded by these objects.
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