Title: Through a Lens, Darkly - New Constraints on the Fundamental Components of the Cosmos
PI: Marc Postman
PI Institution: Space Telescope Science Institute
Science Category: Cosmology
Allocation: 524 orbits

Abstract:
As the most massive objects in the universe, galaxy clusters represent important signposts in our story of structure evolution, and are the ultimate telescopic lenses, placing gravitationally lensed galaxies from the earliest epochs in comfortable reach for careful study. We take full advantage of the refurbished ACS and WFC3 cameras, and make full use of previous HST observations, to deliver deep 14-filter images of 25 carefully chosen clusters. These will enable us to address timely and substantive questions about dark matter, dark energy, and galaxy evolution well beyond z=7. These X-ray clusters are chosen to be free of lensing bias and to span a wide range of redshift (0.15 < z < 0.9) and mass. By combining strong and weak lensing, we will obtain the definitive mass profile of relaxed clusters to confront the distinctive prediction of the standard LambdaCDM model. Detailed maps of internal structure will be enabled by ~1,000 new multiply-imaged lensed sources to AB=26, all with precise (2% x (1+z)) photometric redshift measurements, thanks to WFC3's UV and IR coverage.

A supernovae search will be conducted in the parallel fields, sampling areas subject to low magnification uncertainties. The supernova search component of this program, which is coordinated with the supernova search by Faber et al, will extend the Hubble diagram of SN1a to z>1.5, testing the constancy of dark energy with time and probing progenitor evolution. Follow-up observations, targeting supernovae discovered in the parallel fields, will depend on the apparent redshift of the SN and are likely to include a grism filter from either ACS G800L, WFC3-IR G102 or G141 and light curves observed with G850LP, WFC3-IR F125W, and F160W. Cadence of the observations will depend on the cluster visibility but is likely to be in the range of 1 to 3 weeks. Our homogeneous panchromatic deep imaging of this cluster sample will constitute a vast legacy archive for studies of the formation and evolution of structure.

Clusters to Observer:

Target	RA	Dec
ABELL209	01 31 57.5000	-13 34 35.00
ABELL2261	17 22 28.3000	+32 09 13.00
ABELL383	02 48 6.9000	-03 29 32.00
ABELL611	08 00 58.1000	+36 04 41.00
ABELL963	10 17 9.6000	+39 01 0.00
CLJ1226.9+3332	12 26 58.0000	+33 32 54.00
MACSJ0329.7-0212	03 29 40.8000	-02 11 54.00
MACSJ0416.1-2403	04 16 09.9000	-24 03 58.00
MACSJ0429.6-0253	04 29 36.0000	-02 53 0.00
MACSJ0647.7+7015	06 47 45.9000	+70 15 3.00
MACSJ0717.5+3745	07 17 33.8000	+37 45 20.00
MACSJ0744.9+3927	07 44 51.8000	+39 27 33.00
MACSJ1115.8+0129	11 15 53.3000	+01 29 47.00
MACSJ1149.5+2223	11 49 34.3000	+22 23 42.00
MACSJ1206.2-0847	12 06 12.0000	-08 48 0.00
MACSJ1311.0-0311	13 11 0.0000	-03 11 0.00
MACSJ1423.8+2404	14 23 48.3000	+24 04 47.00
MACSJ1532.8+3021	15 32 54.4000	+30 21 11.00
MACSJ1720.2+3536	17 20 15.5000	+35 36 21.00
MACSJ1931.8-2635	19 31 48.0000	-26 35 0.00
MACSJ2129.4-0741	21 29 26.0000	-07 41 28.00
MACSJ2248.7-4431	22:48:54.3	-44:31:07
MS2137.3-2353	21 40 12.8000	-23 39 27.00
RXJ1347.5-1145	13 47 32.0000	-11 45 42.00
RXJ2129.7+0005	21 29 39.9600	+00 05 21.00

Orbit Allocation (for each Cluster) in Each Filter for ACS and WFC3

Filter	Camera	Orbits	Filter	Camera	Orbits	Filter	Camera	Orbits
F225W	WFC3/UVIS	1.5	F606W	ACS/WFC	1.0	F110W	WFC3/IR	1.0
F275W	WFC3/UVIS	1.5	F775W	ACS/WFC	1.0	F125W	WFC3/IR	2.0
F336W	WFC3/UVIS	1.0	F814W	ACS/WFC	2.0	F140W	WFC3/IR	1.0
F390W	WFC3/UVIS	1.0	F850LP	ACS/WFC	3.0	F160W	WFC3/IR	2.0
F475W	ACS/WFC	1.0	F105W	WFC3/IR	1.0	G800L	ACS/WFC	As Needed

Title: Deep near-infrared survey and high redshift supernovae (final title pending)
PI: Sandra Faber
PI Institution: University of California - Santa Cruz
Co-PI: Harry Ferguson
Institution: Space Telescope Science Institute
Science Category: Unresolved Stellar Populations and Galaxy Structure
Allocation: 902 Orbits

This program represents a combination of two proposals submitted in response to the Multi-Cycle Call. Specifically, following recommendations of the MCT TAC, the combined program incorporates the multi-tier observing strategy from the original Faber proposal with the supernova follow-up strategy described in the Ferguson proposal. The combined team has been instructed to preserve those features in the final program, which will be reviewed by the STScI director and the MCT TAC chair to ensure that those criteria are met, and that the program does not evolve to infringe on any unsuccessful proposals.

Abstract:
This survey will document the first third of galactic evolution from z=8 to 1.5 and test for evolution in the properties of Type Ia supernovae to z~2 by imaging more than 250,000 galaxies with WFC3/IR and ACS. Five premier multi-wavelength regions are selected from within the Spitzer SEDS survey, providing complementary IRAC data down to 26.5 AB mag, a unique resource for stellar masses at high redshifts. The use of five widely separated fields mitigates cosmic variance and yields statistically robust samples of galaxies down to 10^9 M_Sun out to z~8.

This proposal represents the merged science plans from two different MCT proposals. We recognize the need to communicate as precise information as possible for Cycle 18 proposers, but plans are not yet final owing to difficulties in merging two large and complex science programs. The following description represents our best thinking at the present time, and future developments will be posted (with version numbers) ASAP on the new project website: http://csmct.ucolick.org.

The program incorporates a two-tiered strategy using a "Wide" component (2 orbits deep over ~0.2 sq. degrees) and a "Deep" component (12 orbits deep over ~0.04 sq. degrees). Combining these with ultra-deep imaging from the Cycle 17 HUDF09 program yields a three-tiered strategy for efficient sampling of both rare/bright and faint/common objects.

Three of the Wide-survey fields are located within the SEDS regions in COSMOS, EGS, and UKIDSS/UDS (see http://csmct.ucolick.org), with exact areas and placements to be determined as part of the Phase-2 process. Each contiguous Wide mosaic consists of roughly 3x15 WFC3/IR tiles observed for 2 orbits each, with single orbits separated in time to allow a search for high-redshift Type Ia SNe. The co-added exposure times are approximately 2/3 orbit in J (F125W) and 4/3 orbit in H (F160W). ACS parallels overlap most of the WFC3 area and will consist of 2/3 orbits in V (F606W) and 4/3 orbit in I (F814W). Because of the larger area of ACS, this results in effective exposures that are twice as long (4/3 in V, 8/3 in I), making a very significant improvement to existing ACS mosaics in COSMOS and EGS and creating a new ACS mosaic in UDS/UKIDSS where none now exists. Other Wide-survey components are located in the GOODS fields (North and South) surrounding the Deep-survey areas.

The Deep-survey mosaics cover approximately half of each GOODS field, with exact areas and placements again to be determined as part of the Phase-2 process. The location relative to the ERS2 field in GOODS-S is TBD. Each WFC3/IR tile within the Deep regions will receive 12 orbits of effective exposure time split equally between Y (F105W), J (F125W), and H (F160W). Multi-epoch imaging will provide an efficient search for high-redshift Type Ia SNe here also. ACS parallels are taken in the Deep regions with the goal of assembling enough total exposure time in F850LP and other filters to identify high redshift z>6 galaxies in concert with WFC3/IR data using the Lyman break technique. Shallow borders to 2-orbit depth using the Wide WFC3 filter strategy are added around both Deep areas to increase the depth of ACS parallels on top of the Deep area and enlarge the total GOODS area covered.

A portion of the GOODS-N campaign will take place while the field is in the HST Continuous Viewing Zone (CVZ). The bright time in those orbits will be used to obtain UV imaging with WFC3 in the F275W and F336W filters. The exact number of orbits will not be known until Phase-2 planning is complete, but we anticipate that it will be possible to schedule at least 100 orbits, resulting in 5-sigma point-source depths of 26.6, 26.4 AB mag in F275W and F336W, respectively. The science goals include measuring the Lyman-continuum escape fractions for galaxies at z~2.5 and identifying Lyman-break galaxies at z~2-3.

The Type Ia supernova search program in this proposal is integrated with that in the Postman cluster MCT proposal, with this one stressing the more distant supernovae. A combined follow-up program will provide light curves and grism spectra of 15-20 of the best candidates at redshifts $1<z<2$. The observing configuration for the follow-up will depend on the redshift of the supernova and will likely include a grism observation with either ACS G800L, WFC3-IR G102, or G141, and light curves observed with F850LP, WFC3-IR F125W, and F160W.

A representative current strawman proposal looks as follows. We stress that this is not yet final; details may change.

Region	Tiles	WFC3 orbit depth			ACS orbit depth#		
		F105W	F125W	F160W	F606W	F814W	F850LP
Wide*	3x15	---	2/3	4/3	4/3	2/3	---
GOODS^							
Deep	3x5	4	4	4	?	?	?
Border	18	---	2/3	4/3	---	---	2

Effective ACS depth is roughly twice as deep as shown, owing to the larger FOV of ACS.
* Each Wide field in COSMOS, EGS, and UDS/UKIDSS. Substituting F110W for F125W is under consideration.
^ GOODS-N and GOODS-S.

Field Centers	**RA**	**Dec**	**PA on sky**
Wide field COSMOS	10 00 31	+02 24 00	180
Wide field EGS	14 18 36	+52 39 00	41
Wide field UDS	02 17 49	-05 12 02	270
Deep GOODS-S	03 32 30	-27 47 19	160
Deep GOODS-N	12 36 55	+62 14 18	45

The new data will be used to answer many urgent questions in galaxy evolution and cosmology. In the reionization era, we will identify hundreds of high-confidence $z>7$ galaxies in the Deep regions, in addition to hundreds of highly-luminous candidates in the Wide regions for detailed follow-up. These samples will be used to construct a unified picture of star-formation and stellar mass buildup in early galaxies. Extremely deep X-ray data will reveal distant AGNs to $z>6$, shedding light on the earliest stages of BH growth. In the peak star formation/QSO era, $z\sim2$, we will document the properties of early disks, the build-up of bulges, the evolution of mergers, and the nature of AGN hosts to construct an integrated model for structural evolution, star formation quenching, and AGN triggering. Finally, the ~8 Type Ia SNe found beyond $z>1.5$ in the supernova programs will establish the constancy of these standard candles independent of dark energy and yield the first measurement of the Type Ia rate at $z\sim2$ to distinguish among different progenitor models. Lower-redshift SNe Ia at $1<z<1.5$ will be used to measure the evolution of dark energy.

This program takes full advantage of MCTP mode to fulfill Hubble's legacy for deep extragalactic science and prepare the way for JWST.

Title: A Panchromatic Hubble Andromeda Survey
PI: Julianne Dalcanton
PI Institution: University of Washington
Science Category: Resolved Stellar Populations
Allocation: 828 Orbits

Abstract:
We propose to image the north east quadrant of M31 to deep limits in the UV, optical, and near-IR. HST imaging should resolve the galaxy into more than 100 million stars, all with common distances and foreground extinctions. UV through NIR stellar photometry (F275W, F336W with WFC3/UVIS, F475W and F814W with ACS/WFC, and F110W and F160W with WFC3/NIR) will provide effective temperatures for O through M spectral types, while simultaneously mapping M31's extinction. Our central science drivers are to: understand high-mass variations in the stellar IMF as a function of SFR intensity and metallicity; capture the spatially-resolved star formation history of M31; study a vast sample of stellar clusters with a range of ages and metallicities. These are central to understanding stellar evolution and clustered star formation; constraining ISM energetics; and understanding the counterparts and environments of transient objects (novae, SNe, variable stars, x-ray sources, etc.). As its legacy, this survey adds M31 to the Milky Way and Magellanic Clouds as a fundamental calibrator of stellar evolution and star-formation processes for understanding the stellar populations of distant galaxies. Effective exposure times are 400s in F275W, 1800s in F336W, 2800s in F475W, 2880s in F814W, 600s in F110W, and 1600s in F160W, including short exposures to avoid saturation of bright sources. These depths will produce photon-limited images in the UV. Images will be crowding-limited in the optical and NIR, but will reach below the red clump at all radii. The images will reach the Nyquist sampling limit in F160W, F475W, and F814W.

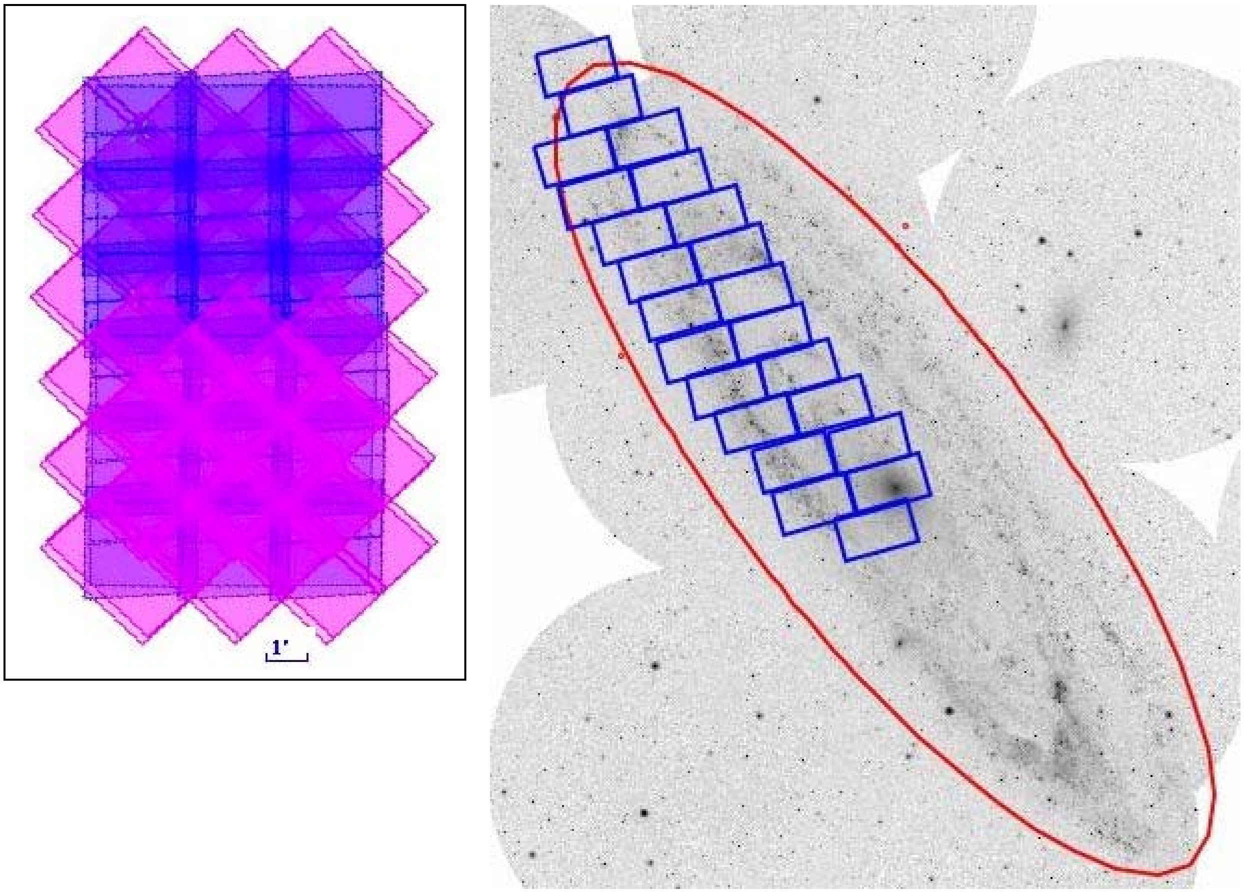

Figure 1: (Left) the 3x6 tiling "brick" used in this program, showing WFC3/UVIS in blue and ACS in magenta; the WFC3-IR pointings are contiguous with minimal overlap, and are not shown. (Right) the distribution of the bricks within M31, superimposed on a GALEX NUV image. The tiling covers the north-east quadrant of the disk.

Tiling Strategy:

Tiling with WFC3/IR (the smallest FOV) simultaneously produces an overlapping grid in ACS, oriented at 45^{o}, with double coverage at all points (and x3 and x5 exposures in overlapping edges and corners). At each pointing, exposures are made in WFC3/IR and in WFC3/UVIS, running ACS/WFC in parallel. The exposures are arranged in strips of 3x6 with a 180^{o} flip in the middle, such that the 9 primary fields from first half overlap the parallel fields from second, producing a 36 orbit 12' x 6'.5 tiling ``brick" that leaves no area without full wavelength coverage. The bricks are arranged contiguously to simplify subsequent analysis.

Exposure Strategy:

The exposure plan balances the aims of (1) imaging 2 filters per camera; (2) achieving Nyquist sampled images through dithering where possible; and (3) avoiding saturation of bright sources, against constraints on the number of images that can be downloaded when running WFC3 & ACS in parallel. APT orbit planning experiments lead to using 1 orbit in WFC3/IR and 1 in WFC3/UVIS at each pointing. The WFC3/IR orbit uses STEP MULTIACCUM sequences (NSAMP=9-10) to produce 4x400s exposures in F160W and 1x600s in F110W. Parallel ACS exposures are 4x340s and 1x40s in F475W, and 1x350s in F814W. The WFC3/UVIS orbit contains 2x400s and 1x900s in F336W, plus 1x100s exposure to avoid saturation and fill the chip gap, and 1x400s F275W exposure. Parallel ACS exposures are 3x350s in F814W plus 1x40s to avoid saturation. Continuous coverage in WFC3/IR produces double overlaps in ACS, effectively doubling the above ACS exposure times (and filling the ACS chip gaps). The dither pattern is designed to work simultaneously in the primary and parallel cameras to produce Nyquist-sampled images in F475W, F814W, and F160W, allowing optimal photometry in crowded regions.

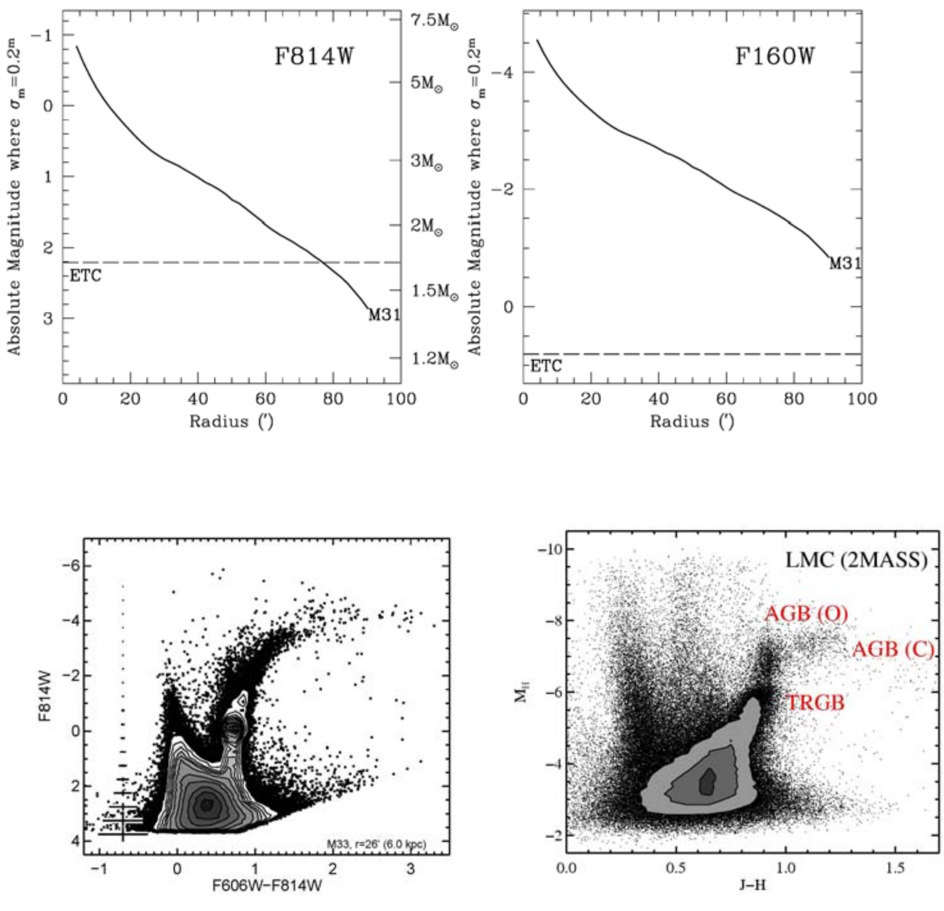

Figure 2: Expected photometric and crowding limits for representative optical/IR filters. The upper panels plot the absolute magnitude where the expected uncertainties reach 0.2 magnitudes: the horizontal dotted line gives the expected level from photon statistics; the solid line outlines the predictions due to crowding. The right-hand axis of the F814W plot indicates the mass of a solar metallicity star at each absolute magnitude. The lower two panels plot color-magnitude diagrams for M33 and the LMC to illustrate the corresponding detection limits in CMD space.