13817 - A Direct Distance to an Ancient Metal-Poor Star Cluster

Cycle: 22, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) NGC6397	WFC3/UVIS	1	16-Jul-2014 21:07:08.0	yes
02	(1) NGC6397	WFC3/UVIS	1	16-Jul-2014 21:07:10.0	yes

2 Total Orbits Used

ABSTRACT

We propose spatial-scanning observations of NGC 6397, an ancient metal-poor globular cluster, in order to obtain a high-precision measurement of its annual trigonometric parallax. Using comprehensive preparations and simulations, we have found that the uncertainty on this direct distance measurement will be approximately 2%. Although dozens of open clusters within 1 kpc have measured parallaxes, to date there has been no measured parallax for a globular cluster. All globular clusters lie further than 1 kpc, and so there are no stellar population anchors at old ages (> 10 Gyr) and low metallicities ([Fe/H] < -1) with direct high-precision distances. Our program will provide the first anchor in this ancient metal-poor

regime, with implications for a wide variety of stellar population studies, particularly in the realm of star formation histories.

OBSERVING DESCRIPTION

Our proposal obtains a high-precision distance to the metal-poor GC NGC6397 using the spatial-scanning capability of WFC3/UVIS. Our preparations include selection of the best field location and orientation, taking into account the number of cluster and field stars with useful scans (uncontaminated by neighbors), appropriate sampling of the parallax ellipse, schedulability, and scan position angle relative to the parallactic motion at the time of each observation. In each single-orbit epoch, we can execute 4 spatial scans in the F606W filter (forward, reverse, forward, reverse) of 3600-pixel length, plus 8 unscanned images binned 2x2. These binned images will employ the F336W, F467M, F547M and F850LP filters. The resulting 4-filter photometry, when combined with ground-based spectroscopy of the field stars, will enable the required constraints on the absolute parallax reference frame. We will obtain multiple images in each filter for the entire scanned area, enabling cosmic-ray rejection and increased dynamic range. The program will eventually obtain five single-orbit epochs, at six month intervals (September and March) that sample the times of maximum parallactic motion. We should have at least a week of schedule availability for each epoch, at the appropriate orientation and date. We leave a few minutes of unused visibility to ensure scheduling. The orientation and cadence are constrained, but a single orbit within a 1-week period, repeated every 6 months with exact 180 degree flips in orientation, should not present a burden to the HST scheduling system. Each spatial scan is nearly along the y-axis of the detector (0.05 degree offset), minimizing the effect of charge transfer inefficiency, but providing subsampling of the point spread function in the resolution direction (perpendicular to the scan).

Ideally, we would observe on Sep 18 2014 and Mar 19 2015, which would be the time of maximum offset on the parallax ellipse, but observations within a week of these dates have little impact on the fidelity of the measurement.

Ideally, we would scan at a position angle of 2.9 degrees (perpendicular to the semi-major axis of the parallax ellipse), corresponding to an orientation of 138 degrees for WFC3. However, that roll angle is unavailable at the appropriate dates, and the roll angle must also be chosen to obtain clean scans of the desired stars. So, 110.5 and 290.5 degrees are used.

The binned imaging needs to provide photometry that does not saturate the ADC (65,000 DN) in 4 pixels while providing good signal-to-noise. At a gain of 1.5, that means the central 4 pixels should have less than 100,000 e-. The ensquared energy in the central 2x2 pixels of the PSF is 2.8x higher than that in the central pixel, according to the handbook. To be conservative, assume the central unbinned pixel should have ~<30,000 e- (note full well is ~70,000 e-). Using Stromgren photometry of reference stars in the field, the range of most interest can be represented by two stars at ~4500K

and ~5000K, with V=11.5 mag and V=15.6 mag.

Count rate in central unbinned pixel (e-/s)

Filter	4500K/11.5mag	5000K/15.6mag
F336W	1307	67
F467M	9425	219
F547M	39435	825
F850LP	33202	508

Exposure times of 20, 2, 1, & 1 sec for the F336W, F467M, F547M, and F850LP should be unsaturated at the bright end and have good SNR at the faint end. To improve the SNR at the faint end, take pairs of images at each position with each filter, with the second exposure being longer than the times here.

Visit

Proposal 13817, Epoch 1 of 5 (01) Thu Jul 17 01:07:12 GMT 2014

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 110.5D TO 110.5 D; BETWEEN 11-SEP-2014:00:00:00 AND 25-SEP-2014:00:00:00

Comments: Note that SAME OBSET is required to keep the 12 exposures within a single visibility period and avoid multiple GS ACQs.

The use of "GS ACQ Scenario" in the first exposure has been used in previous spatial scanning programs but was not used here. If it is needed to execute properly, please contact the PI.

Diagnostics

(Epoch 1 of 5 (01)) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

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(Epoch 1 of 5 (01)) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

Fixed Targets

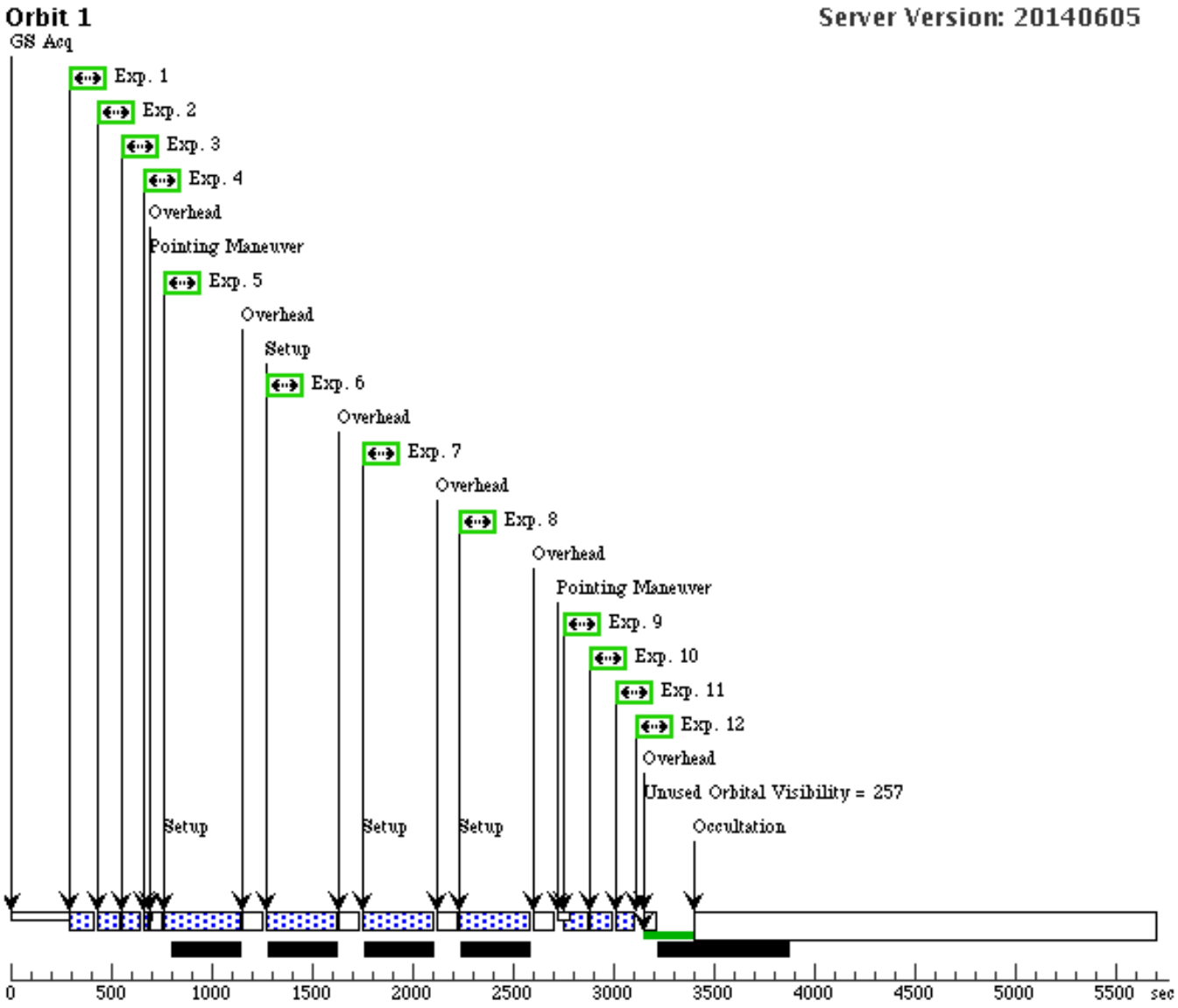
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC6397	RA: 17 40 50.3975 (265.2099896d) Dec: -53 31 48.00 (-53.53000d) Equinox: J2000		V=5.7+/-0.1	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F336W	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,-72	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	20 Secs (20 Secs) *[==>]*	***[1]***
2		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F336W	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,-72	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	40 Secs (40 Secs) *[==>]*	***[1]***
3		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F467M	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,-72	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	2 Secs (2 Secs) *[==>]*	***[1]***
4		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F467M	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,-72	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	20 Secs (20 Secs) *[==>]*	***[1]***
5		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W		POS TARG 0,-72; SPATIAL SCAN 0.41,90.05 Degrees,Forward	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	350 Secs (350 Secs) *[==>]*	***[1]***
6		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W		POS TARG 0,-72; SPATIAL SCAN 0.41,90.05 Degrees,Reverse	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	350 Secs (350 Secs) *[==>]*	***[1]***
7		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W		POS TARG 0,-72; SPATIAL SCAN 0.41,90.05 Degrees,Forward	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	350 Secs (350 Secs) *[==>]*	***[1]***
8		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W		POS TARG 0,-72; SPATIAL SCAN 0.41,90.05 Degrees,Reverse	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	350 Secs (350 Secs) *[==>]*	***[1]***
9		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F336W	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,72	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	20 Secs (20 Secs) *[==>]*	***[1]***

	10	(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F336W	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,72	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	40 Secs (40 Secs) *[==>]*	***[1]***
	11	(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F467M	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,72	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	2 Secs (2 Secs) *[==>]*	***[1]***
	12	(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F467M	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,72	Sequence 1-12 Non-Int in Epoch 1 of 5 (01) Same Obset in Sequence 1-12 Non-Int in Epoch 1 of 5 (01)	20 Secs (20 Secs) *[==>]*	***[1]***

Orbit Structure



Visit

Proposal 13817, Epoch 2 of 5 (02) Thu Jul 17 01:07:12 GMT 2014

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 290.5D TO 290.5 D; BETWEEN 12-MAR-2015:00:00:00 AND 26-MAR-2015:00:00:00

Comments: Note that SAME OBSET is required to keep the 12 exposures within a single visibility period and avoid multiple GS ACQs.

The use of "GS ACQ Scenario" in the first exposure has been used in previous spatial scanning programs but was not used here. If it is needed to execute properly, please contact the PI.

Must execute 180 degrees from Visit 1.

Diagnostics

(Epoch 2 of 5 (02)) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING
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Fixed Targets

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Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F547M	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,-72	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	1 Secs (1 Secs) *[==>]*	***[1]***
2		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F547M	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,-72	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	10 Secs (10 Secs) *[==>]*	***[1]***
3		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F850LP	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,-72	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	1 Secs (1 Secs) *[==>]*	***[1]***
4		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F850LP	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,-72	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	10 Secs (10 Secs) *[==>]*	***[1]***
5		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W		POS TARG 0,-72; SPATIAL SCAN 0.4 1,90.05 Degrees,Forward	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	350 Secs (350 Secs) *[==>]*	***[1]***
6		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W		POS TARG 0,-72; SPATIAL SCAN 0.4 1,90.05 Degrees,Reverse	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	350 Secs (350 Secs) *[==>]*	***[1]***
7		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W		POS TARG 0,-72; SPATIAL SCAN 0.4 1,90.05 Degrees,Forward	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	350 Secs (350 Secs) *[==>]*	***[1]***
8		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W		POS TARG 0,-72; SPATIAL SCAN 0.4 1,90.05 Degrees,Reverse	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	350 Secs (350 Secs) *[==>]*	***[1]***
9		(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F547M	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,72	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	1 Secs (1 Secs) *[==>]*	***[1]***

	10	(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F547M	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,72	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	10 Secs (10 Secs) *[==>]*	***[1]***
	11	(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F850LP	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,72	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	1 Secs (1 Secs) *[==>]*	***[1]***
	12	(1) NGC6397	WFC3/UVIS, ACCUM, UVIS-CENTER	F850LP	CR-SPLIT=NO; BIN=2; FLASH=10	POS TARG 0,72	Sequence 1-12 Non-Int in Epoch 2 of 5 (02) Same Obset in Sequence 1-12 Non-Int in Epoch 2 of 5 (02)	10 Secs (10 Secs) *[==>]*	***[1]***

Orbit Structure