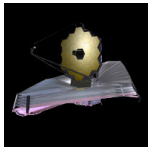

1979 - The faintest and coolest stars in the two closest globulars

Cycle: 1, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	NGC6397	NIRCam Imaging	(1) NGC-6397
Observation Folder				
	2	M4	NIRCam Imaging	(2) M-4
	3	M4-link	NIRCam Imaging	(3) M-4-shift

ABSTRACT

Globular clusters (GCs) are the oldest objects in the Universe for which accurate ages can be determined. They are ideal laboratories because, to first approximation, they consist of stars of the same age, distance, and chemical composition. Stellar color-magnitude diagrams (CMDs) of GCs are

important tools for stellar astrophysics and dynamics.

We propose to use JWST in direct-imaging mode with NIRCam and NIRISS to obtain high-precision photometry and astrometry of the faintest objects in the two closest GCs: M4 and NGC6397. Our program is two-fold:

(1) We intend to map the transition in the CMD and in the luminosity function between stars fusing Hydrogen and non-fusing brown dwarfs (BDs). Observations of GC BDs are crucial for testing and calibrating metal-poor models of BD atmospheres, formation and evolution.

(2) We will also be sensitive to the entire white dwarf (WD) cooling sequence in the infrared. This will extend existing HST photometry, allowing us to probe fundamental astrophysics and search for evidence in the colours of hotter WDs for (or against) the existence of ancient planetary systems from the presence (or not) of IR excesses.

Understanding field contamination in GC observations is fundamental, and the proposed program will be used to test JWST’s astrometric capabilities by determining proper-motion membership of target sources using existing high-resolution HST images that just reach the star/BD limit, 15 yrs ago. Future JWST epochs will allow us to extend proper-motion membership to fainter objects and well into the BD sequence.

Finally, our reduced data and high-accuray astrometric & photometric tools will be made publicly and timely available.

OBSERVING DESCRIPTION

In this program, we propose to use JWST in direct-imaging mode with NIRCam (and in parallel with NIRISS) to obtain high-precision photometry and astrometry of the faintest objects within the two geometrically closest globular clusters (GC): NGC 6397 and M4 (aka, NGC 6121).

We need to map a relatively large field of view to have a statistically significant number of expected white dwarfs (WDs), low mass Main-Sequence stars, and brown dwarfs (BDs), therefore we use NIRCam and in parallel NIRISS (the widest imagers on the JWST focal plane) as coordinated parallel observations.

As GC's members are completely lost in the mixture of objects in their foreground and background, astrometry is a fundamental part of this investigation, and we intend to probe both the astrometric and photometric capabilities of JWST in this program. Multiple dithered images each with relatively high S/N are necessary to provide a number of inter-comparisons of detectors' regions to calibrate (or to correct for residual in) the

geometric distortion of the camera, the spatial and temporal variability of the PSFs, and the local photometric zero points.

We will take advantage as much as possible of existing archival HST/ACS/WFC/F814W deep images (from GO-10424 and GO-10146) to have a first epoch enable to separate members stars from field objects in background and foreground of the two target GCs, however only the WDCS were observed completely. We will also use, at their full potential, the IR images available for M4 with WFC3/IR/F110W+F160W under programs GO-12602 & GO-14725, much shallower than the IR JWST observations here proposed, but nevertheless the space-based deepest IR images available.

Precise and accurate astrometry, will not only be used for proper-motion cluster memberships, but it will be used also for analyses of the GC internal kinematics (such investigations are beyond Gaia's capabilities, as the stars too red & faint and in crowded environments).

We have chosen the JWST NIRCAM ultra-wide filters F150W2 and F322W2 because they can be used for simultaneous observations and their large throughput is suitable for deep observations of old cool faint WDs and BDs. We plan to have NIRISS parallel images to increase the field coverage, avoiding bright objects, and in the water sensitve filter F150W.

This proposal evolved from an originary unsuccessful proposal submitted to ESRs with two Co-PIs, since then the large team split in two groups, and evolved in two competing proposals by two different teams, with different targets and aiming at slightly different science. We have no way to know for sure which parts, but we fear that there might be some overlapping text in two proposals.

Proposal 1979 - Targets - The faintest and coolest stars in the two closest globulars

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	NGC-6397	RA: 17 41 6.0000 (265.2750000d) Dec: -53 45 20.00 (-53.75556d) Equinox: J2000	Proper Motion RA: 3.713876364015E-4 sec of time/yr Proper Motion Dec: -0.017600000023776374 arcsec/yr Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Category=Stellar Cluster Description=[Globular star clusters]				
(2)	M-4	RA: 16 23 43.2500 (245.9302083d) Dec: -26 27 0.00 (-26.45000d) Equinox: J2000	Proper Motion RA: -9.298862519940784E-4 sec of time/yr Proper Motion Dec: -0.018989999921359413 arcsec/yr Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Category=Stellar Cluster Description=[Globular star clusters]				
(3)	M-4-shift	RA: 16 23 38.0000 (245.9083333d) Dec: -26 30 5.00 (-26.50139d) Equinox: J2000	Proper Motion RA: -9.298862519940784E-4 sec of time/yr Proper Motion Dec: -0.018989999921359413 arcsec/yr Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Category=Stellar Cluster Description=[Globular star clusters]				

Observation

Proposal 1979, Observation 1: NGC6397

Mon Mar 27 21:01:32 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Coordinated Parallel Template(s): NIRISS Imaging

Diagnostics

(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	NGC-6397	RA: 17 41 6.0000 (265.2750000d)	Proper Motion RA: 3.713876364015E-4 sec of time/yr	
		Dec: -53 45 20.00 (-53.75556d)	Proper Motion Dec: -0.017600000023776374 arcsec/yr	
		Equinox: J2000	Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Stellar Cluster
Description=[Globular star clusters]

Template

NIRCam Imaging	NIRISS Imaging
Module: ALL	
Subarray: FULL	
Target Placement: Module Gap	

Dithers

#	Primary Dither Type	Primary Dithers	Dither Size	Subpixel Positions	Coordinated Parallel Subpixel Selector	Dither Direct Images Primes
1	FULLBOX	6		1	2-POINT-LARGE-WITH-NIRISS	NO_DITHERING

Spectral Elements

NIRCam Imaging	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F150W2	F322W2	MEDIUM8	6	1	12	12	7472.792	

Spectral Elements

NIRISS Imaging	Filter	Grism	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F150W		NIS	14	1	12	12	7343.951	

Special Requirements	
	Between Dates 13-MAR-2023:00:00:00 and 21-MAR-2023:00:00:00 Aperture PA Range 267 to 267 Degrees (V3 267.0713531 to 267.0713531) No Parallel Attachments Background Limited. Background no more than 40th percentile above minimum

Observation

Proposal 1979, Observation 2: M4

Mon Mar 27 21:01:32 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Coordinated Parallel Template(s): NIRISS Imaging

Diagnostics

(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 2:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	M-4	RA: 16 23 43.2500 (245.9302083d) Dec: -26 27 0.00 (-26.45000d) Equinox: J2000	Proper Motion RA: -9.298862519940784E-4 sec of time/yr Proper Motion Dec: -0.018989999921359413 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Stellar Cluster
Description=[Globular star clusters]

Template

NIRCam Imaging	NIRISS Imaging
Module: ALL	
Subarray: FULL	
Target Placement: Module Gap	

Dithers

#	Primary Dither Type	Primary Dithers	Dither Size	Subpixel Positions	Coordinated Parallel Subpixel Selector	Dither Direct Images Primes
1	FULLBOX	6		1	2-POINT-LARGE-WITH-NIRISS	NO_DITHERING

Spectral Elements

NIRCam Imaging	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F150W2	F322W2	MEDIUM8	5	1	12	12	6184.38	

Spectral Elements

NIRISS Imaging	Filter	Grism	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F150W		NIS	11	1	12	12	5797.856	

Special Requirements	
	Between Dates 30-MAR-2023 and 13-APR-2023 Aperture PA Range 290 to 290 Degrees (V3 290.0713531 to 290.0713531) No Parallel Attachments Background Limited. Background no more than 10th percentile above minimum 3 After 2 Same Aperture PA 2, 3

Observation

Proposal 1979, Observation 3: M4-link Mon Mar 27 21:01:32 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Coordinated Parallel Template(s): NIRISS Imaging

Diagnostics

(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 3:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	M-4-shift	RA: 16 23 38.0000 (245.9083333d) Dec: -26 30 5.00 (-26.50139d) Equinox: J2000	Proper Motion RA: -9.298862519940784E-4 sec of time/yr Proper Motion Dec: -0.018989999921359413 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Stellar Cluster
Description=[Globular star clusters]

Template

NIRCam Imaging	NIRISS Imaging
Module: ALL	
Subarray: FULL	
Target Placement: Module Gap	

Dithers

#	Primary Dither Type	Primary Dithers	Dither Size	Subpixel Positions	Coordinated Parallel Subpixel Selector	Dither Direct Images Primes
1	NONE			1	3-POINT-LARGE-WITH-NIRISS	NO_DITHERING

Spectral Elements

NIRCam Imaging	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F150W2	F322W2	BRIGHT2	6	1	3	3	386.524	

Spectral Elements

NIRISS Imaging	Filter	Grism	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F150W		NISRAPID	11	1	3	3	386.524	

Special Requirements	
	No Parallel Attachments Background Limited. Background no more than 10th percentile above minimum 3 After 2 Same Aperture PA 2, 3