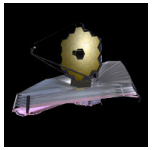

1334 - The Resolved Stellar Populations Early Release Science Program

Cycle: 1, Proposal Category: ERS

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
M92				
	1	M92	NIRCam Imaging	(1) M92
WLM				
	5	WLM	NIRCam Imaging	(2) WLM
Draco II				
	3	Draco II	NIRCam Imaging	(3) DRACO-II

ABSTRACT

We propose to obtain deep multi-band NIRCam and NIRISS imaging of three resolved stellar systems within 1 Mpc (NOI 104). We will use this broad science program to optimize observational setups and to develop data reduction techniques that will be common to JWST studies of resolved stellar populations. We will combine our expertise in HST resolved star studies with these observations to design, test, and release point spread function (PSF) fitting software specific to JWST. PSF photometry is at the heart of resolved stellar populations studies, but is not part of the standard JWST reduction pipeline.

Our program will establish JWST-optimized methodologies in six scientific areas: star formation histories, measurement of the sub-Solar mass stellar IMF, extinction maps, evolved stars, proper motions, and globular clusters, all of which will be common pursuits for JWST in the local Universe. Our observations of globular cluster M92, ultra-faint dwarf Draco II, and star-forming dwarf WLM, will be of high archival value for other science such as calibrating stellar evolution models, measuring properties of variable stars, and searching for metal-poor stars.

We will release the results of our program, including PSF fitting software, matched HST and JWST catalogs, clear documentation, and step-by-step tutorials (e.g., Jupyter notebooks) for data reduction and science application, to the community prior to the Cycle 2 Call for Proposals. We will host a workshop to help community members plan their Cycle 2 observations of resolved stars. Our program will provide blueprints for the community to efficiently reduce and analyze JWST observations of resolved stellar populations.

OBSERVING DESCRIPTION

We will image M92 with NIRCam in two short-wavelength filters (F090W, F150W) and two long-wavelength filters (F277W, F444W). Our science and technical goals require that our NIRCam short-wavelength observations reach a 0.1 Msun star (m_F090W=26 and m_F150W=25.8) with SNR=10. Both NIRCam modules will be placed near the center of M92 to enable testing of PSF photometry routines and benchmark the ETC in a crowded environment, as well as to measure internal proper motions in tandem with archival HST imaging. The NIRCam long-wavelength filters will reach similar depths as the short-wavelength filters. We will also acquire NIRISS imaging in the F090W and F150W filters as a coordinated parallel observation. The parallel observations will achieve nearly the same photometric depth as the primary NIRCam observations. We will employ a 4-point sub-pixel dither in both NIRCam and NIRISS to mitigate cosmic rays, hot pixels, and improve sampling of the PSF. We will use a SHALLOW4 readout with 6 groups and 1 integrations for all observations. The ~10 sec exposure from the first frame will mitigate most saturation effects. JWST ETC v1.5.1.1 suggests that science times of 1288s in F090W/F277W and 1288s in F150W/F444W are sufficient to achieve our target depths. Parallel NIRISS imaging will have 1074s in F090W and 1074s in F150W of science time. We verified that these requests were reasonable using archival HST/IR imaging. M92 is visible for 44 days during the revised ERS window (153 in the original window). We have constrained the

positions and orientation to ensure maximal overlap between NIRCam and archival HST imaging.

We will image Draco II with NIRCam in two short-wavelength filters (F090W, F150W) and two long-wavelength filters (F480M, F360M). Our science and technical goals require that our NIRCam short-wavelength observations reach a 0.2 Msun star (m_F090W=27 and m_F150W=26.8) with SNR=10. Both NIRCam modules will be oriented to maximally cover the half-light radius of Draco II and will overlap existing deep HST data to allow proper motion measurements. The NIRCam long-wavelength filters will reach depths ~3 magnitudes brighter than the short-wavelength depths. We will also acquire NIRISS imaging in the F090W and F150W filters as a coordinated parallel observation. The parallel observations will achieve nearly the same photometric depth as the primary NIRCam observations, and will be placed outside of Draco II, allowing us to build an empirical model of background galaxy colors and magnitudes. We will employ a 4-point sub-pixel dither in both NIRCam and NIRISS to mitigate cosmic rays, hot pixels, and improve sampling of the PSF. We will use a MEDIUM8 readout with 7 groups and 4 integrations for F090W/F480M and 7 groups and 2 integrations for F150W/F360M. JWST ETC v1.5.2.1 suggests that science times of 11810s in F090W/F277W and 5883s in F150W/F444W are sufficient to achieve our target depths. Parallel NIRISS imaging will have 11123s in F090W and 5282s in F150W of science time. We have not requested orientation constraints. We verified that these requests were reasonable using archival HST/ACS imaging. Draco II is visible for almost 5 months in the 2021/2022 ERS window.

We will image WLM with NIRCam in two short-wavelength filters (F090W, F150W) and two long-wavelength filters (F430M, F250M). Our science and technical goals require that our NIRCam short-wavelength observations reach the oldest main sequence turnoff of a metal-poor population (m_F090W=28.3 and m_F150W=28.1) with SNR=10. Both NIRCam modules will be oriented to maximally cover the central star-forming disk of WLM to enable star formation history determination, AGB star identification, and mapping of the cold ISM. The position and orientation of the NIRCam field will overlap with new and archival HST UV and optical data. The NIRCam long-wavelength filters will reach depths of ~24-25, which is sufficient for AGB star science. We will also acquire NIRISS imaging in the F090W and F150W filters as a coordinated parallel observation. The parallel observations will achieve photometric depths ~0.5 mag brighter than the primary NIRCam observations, enabling the measurement of a detailed star formation history in WLM's less crowded outer disk. We will employ a 4-point sub-pixel dither in both NIRCam and NIRISS to mitigate cosmic rays, hot pixels, and improve sampling of the PSF. We will use a MEDIUM8 readout with 8 groups and 9 integrations for F090W/F430M and 8 groups and 7 integrations for F150W/F250M. We request the observations in a single block to enable sampling of short period variables. We also request position angles between 90 and 100 or 260 and 280 degrees to ensure overlap with the CO clouds and HST UV imaging. JWST ETC v1.5.2.1 suggests that science times of 30492s in F090W/F430M and 23706s in F150W/F250M are sufficient to achieve our target depths. Parallel NIRISS imaging will have 26670s in F090W and 19841s in F150W of science time. This strategy is designed to maximize photometric depth while minimizing overheads. We verified that these requests were reasonable using archival HST/ACS imaging. At the specified

orientation, WLM is visible for 16 days during the revised 2022 ERS window (47 days during the original window). STScI indidates that even as few as 8 scheduable days is sufficiently long for an ERS program to be executed.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	M92	RA: 17 17 7.2061 (259.2800254d) Dec: +43 08 8.39 (43.13566d) Equinox: J2000		
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Stellar Cluster* *Description=[Globular star clusters]*				
(2)	WLM	RA: 00 01 57.4295 (.4892896d) Dec: -15 28 52.49 (-15.48125d) Equinox: J2000		
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Galaxy* *Description=[Dwarf galaxies, Dwarf irregular galaxies]*				
(3)	DRACO-II	RA: 15 52 47.6000 (238.1983333d) Dec: +64 33 55.00 (64.56528d) Equinox: J2000		
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Galaxy* *Description=[Dwarf galaxies, Dwarf spheroidal galaxies]*				

Observation

Proposal 1334, Observation 1: M92 Fri Jun 24 03:00:14 GMT 2022

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Coordinated Parallel Template(s): NIRISS Imaging

Comments: We have selected a position and range of oritentaitons that maximize oppotunties for overlap between NIRCam and archival HST imaging. Within the revised ERS window, this restricts visbility to the end of the window (i.e., April 2020). In the event that the window is further revised, M92 is well-positioned for easy scheduling.

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)	M92	RA: 17 17 7.2061 (259.2800254d) Dec: +43 08 8.39 (43.13566d) Equinox: J2000		

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	

Dithers

#	Primary Dither Type	Primary Dithers	Dither Size	Subpixel Positions	Coordinated Parallel Subpixel Selector	Dither Direct Images Primes
1	NONE			1	4-POINT-MEDIUM-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	F090W	F277W	SHALLOW4	6	1	4	4	1245.465	
2	F150W	F444W	SHALLOW4	6	1	4	4	1245.465	

Spectral Elements

NIRISS Imaging	Filter	Grism	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F090W		NIS	7	1	4	4	1245.465	
2	F150W		NIS	7	1	4	4	1245.465	

Special Requirements	Aperture PA Range 156 to 226 Degrees (V3 156.09730273 to 226.09730273) No Parallel

Observation

Proposal 1334, Observation 5: WLM Fri Jun 24 03:00:14 GMT 2022

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Coordinated Parallel Template(s): NIRISS Imaging

Comments: The orientation is constainted to maximize the odds that NIRCam overlap with exisiting WFPC2 optical data and planned HST cycle 25 UV imaging while still leaving a reasonable window for scheduling. NIRISS will sample a naew part of WLM's outer disk or halo population no matter the orientation.

Diagnostics

(Visit 5:1) Warning (Form): Data Excess over lower threshold

(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	WLM	RA: 00 01 57.4295 (.4892896d) Dec: -15 28 52.49 (-15.48125d) Equinox: J2000		

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Galaxy
Description=[Dwarf galaxies, Dwarf irregular galaxies]

Template

NIRCam Imaging	NIRISS Imaging
Module: ALL	
Subarray: FULL	

Dithers

#	Primary Dither Type	Primary Dithers	Dither Size	Subpixel Positions	Coordinated Parallel Subpixel Selector	Dither Direct Images Primes
1	NONE			1	4-POINT-MEDIUM-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	F090W	F430M	MEDIUM8	8	9	36	4	30492.427	
2	F150W	F250M	MEDIUM8	8	7	28	4	23706.788	

Spectral Elements

NIRISS Imaging	Filter	Grism	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F090W		NIS	17	9	4	36	26670.137	
2	F150W		NIS	19	6	4	24	19841.551	

Special Requirements	
	Aperture PA Range 90 to 100 Degrees (V3 90.09730273 to 100.09730273) Aperture PA Range 260 to 280 Degrees (V3 260.09730273 to 280.09730273) No Parallel

Observation

Proposal 1334, Observation 3: Draco II Fri Jun 24 03:00:14 GMT 2022

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Coordinated Parallel Template(s): NIRISS Imaging

Comments: We do not require any orietnation constraints. The central NIRCam pointing will share at least some overlap with exisiting ACS data, as well as Keck spectroscopy. An orientation of 212 degrees causes the NIRISS field to overlap with a spectroscopically confirmed member star. However, it also reduces schedulablity to a handful of days. Our preference is to maximize schedulablity rather than overlap with one Keck data point.

Diagnostics

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	DRACO-II	RA: 15 52 47.6000 (238.1983333d) Dec: +64 33 55.00 (64.56528d) Equinox: J2000		

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Galaxy
Description=[Dwarf galaxies, Dwarf spheroidal galaxies]

Template

NIRCam Imaging	NIRISS Imaging
Module: ALL	
Subarray: FULL	

Dithers

#	Primary Dither Type	Primary Dithers	Dither Size	Subpixel Positions	Coordinated Parallel Subpixel Selector	Dither Direct Images Primes
1	NONE			1	4-POINT-MEDIUM-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	F090W	F480M	MEDIUM8	7	4	16	4	11810.447	
2	F150W	F360M	MEDIUM8	7	2	8	4	5883.75	

Spectral Elements

NIRISS Imaging	Filter	Grism	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F090W		NIS	9	7	4	28	11123.294	
2	F150W		NIS	10	3	4	12	5282.491	

Special Requirements	
	Aperture PA Range 47 to 118 Degrees (V3 47.09730273 to 118.09730273) Aperture PA Range 143 to 280 Degrees (V3 143.09730273 to 280.09730273) Aperture PA Range 354 to 24 Degrees (V3 354.09730273 to 24.09730273) No Parallel