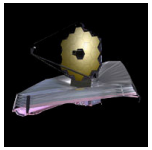

1433 - Physical Properties of the Triply-Lensed z = 11 Galaxy

Cycle: 1, Proposal Category: GO

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OBSERVATIONS

Folder	***Observation***	***Label***	***Observing Template***	***Science Target***
Observation Folder				
	10	NIRCam Imaging	NIRCam Imaging	(1) MACS0647+7015
	20	NIRCam Imaging	NIRCam Imaging	(1) MACS0647+7015
	21	NIRSpec MSA 1	NIRSpec MultiObject Spectroscopy	(11) MACS0647-MSA-TARGETS
	22	NIRSpec MSA 2	NIRSpec MultiObject Spectroscopy	(11) MACS0647-MSA-TARGETS
	23	NIRSpec MSA 3	NIRSpec MultiObject Spectroscopy	(23) MACS0647-MSA-OBS23

ABSTRACT

The z = 11.1 galaxy MACS0647-JD is one of the two most distant objects known. It is strongly lensed by a foreground cluster to form three images, with AB mag = 25.9, 26.1, and 27.3, which enables a detailed study with JWST. This provides us with a unique opportunity to begin to study the

early phases of galaxy formation at the cosmic age of only 400 Myr, aided by nature's own cosmic lens. Despite the magnification, the system is spatially unresolved with HST, which means its radius must be < 100 pc, the size of Giant Molecular Clouds. Packed into that small radius is a significant stellar mass (1e7 – 1e9 Msun) that is producing new stars at a rate of a few Msun / yr. Our proposed NIRCam and NIRSpec observations will allow us to obtain significant new insights into the nature of this young galaxy that are beyond the reach of current facilities, including:

1) A precise spectroscopic redshift from one or more lines

2) More precise measurements of the SFR, stellar mass, age, and dust extinction

3) Delensed spatial resolution down to 30 pc to estimate the galaxy's effective radius and constrain the properties of smaller structures within

4) First constraints on metallicity and ionizing strength of a galaxy at z=11

In addition to the z=11 galaxy, we will study the large number of (~30) known z ~ 6 – 8 candidates in this field plus new discoveries of fainter candidates at z ~ 6 – 11 and perhaps beyond in this exceptional strong lensing field. We waive exclusive access to all data obtained from this program, and will release reduced data products, lens models, and analysis notebooks to aid the community.

OBSERVING DESCRIPTION

We are obtaining NIRCam imaging and NIRSpec MSA prism on one target field: MACS0647. Epoch 1 obtained NIRCam imaging in 6 wide filters. Epoch 2 will obtain imaging in 2 filters (repeating F200W and adding F480M) and NIRSpec MSA spectroscopy.

The NIRCam imaging is serving as pre-imaging for NIRSpec. Despite the limited coverage, it should yield sufficient reference objects, including both stars and compact galaxies. NIRSpec MSA will follow at least 60 days later.

This APT resubmission includes fully prepared NIRSpec MSA PRISM observations.
- Obs 21: single slitlets; 2 dithers = 2 MSA configurations
- Obs 22: FAILED
- Obs 23: 3-slitlet nods

The primary science targets are multiply-lensed images of a z = 11 galaxy MACS0647-JD. The primary goal is to detect one or more spectral emission lines. This is not guaranteed. Line strengths and signal-to-noise estimates are uncertain, and in some cases we don't have much margin.

We prioritize coverage of the red end of the spectra 4.5 -- 5.3 microns where we cover our best hopes to detect one or more lines: [OII], NeIII, and H gamma (rest-frame 3700 -- 4400 Angstroms). (We do not prioritize the Lyman break that should be observed around ~1.5 microns, nor Lyman alpha which should be absorbed by the IGM.) Our spectra are being dispersed towards the SW, and each PRISM trace covers the length of one MSA footprint.

This requires compromises. Most significantly, we focus on the brighter lensed images JD1 and JD2, and we do not cover the fainter JD3. We do stretch a bit to cover a lensed z = 5 star candidate (similar to Earendel at z = 6) in one of the two observations. Thus, 3 of our spectra (2 for JD1 + 1 for JD2) will have full red coverage, while the 4th may lose H gamma in one observation, depending on the redshift (e.g., z ~ 10.6 vs. 11.1).

We also avoid a bright 8th magnitude star, avoiding the MSA FOV in all exposures. We interleave our 2 MSA configurations to cover area, including some of the "other" NIRCam module offset from the lensing cluster observing mostly "blank" sky.

NIRCam imaging revealed the lensed z=11 galaxy JD to be two clumps (or merging galaxies). We target the brighter clump A. The fainter clump B is observed only ~0.2" away and its light may contribute to some of the spectra. It falls within our JD2 slits; not JD1.

Our MSA catalogs include entries for blank sky regions where we will obtain spectra to measure backgrounds. Defined simply on a grid, some could contain objects, yielding serendipitous spectra.

The catalogs also include reference objects, measured to be compact (or have compact cores) and isolated as determined in NIRCam images and HST images (obtained in 2006 and 2011) for wider coverage. All HST and JWST images were aligned to Gaia DR3 before analysis.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	MACS0647+7015	RA: 06 47 50.0000 (101.9583333d) Dec: +70 14 55.00 (70.24861d) Equinox: J2000		
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Clusters of Galaxies* *Description=[Rich clusters]*				
(11)	MACS0647-MSA-TARGETS	RA: 06 47 48.8311 (101.9534629d) Dec: +70 14 11.65 (70.23657d) Equinox: J2000		
Comments: *Description=[]*				
(23)	MACS0647-MSA-OBS23	RA: 06 47 50.4007 (101.9600029d) Dec: +70 14 38.12 (70.24392d) Equinox: J2000		
Comments: *Description=[]*				

Observation

Proposal 1433, Observation 10: NIRCam Imaging Mon Jan 30 16:01:00 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Diagnostics

(Visit 10:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	MACS0647+7015	RA: 06 47 50.0000 (101.9583333d) Dec: +70 14 55.00 (70.24861d) Equinox: J2000		

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Clusters of Galaxies
Description=[Rich clusters]

Template

Module	Subarray
ALL	FULL

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	INTRAMODULEBOX	4	STANDARD		1

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F115W	F444W	SHALLOW4	10	1	4	4	2104.407	
2	F150W	F356W	SHALLOW4	10	1	4	4	2104.407	
3	F200W	F277W	SHALLOW4	10	1	4	4	2104.407	

Special Requirements

Aperture PA Range 80 to 285 Degrees (V3 80.0713531 to 285.0713531)
Offset -86.0 arcsec, 0.0 arcsec
Background Limited. Background no more than 40th percentile above minimum

21 After 10 by 60.0 Days to <None specified>
22 After 10 by 60.0 Days to <None specified>
23 After 10 by 60.0 Days to <None specified>

Observation

Proposal 1433, Observation 20: NIRCam Imaging Mon Jan 30 16:01:00 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Diagnostics

(Visit 20:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	MACS0647+7015	RA: 06 47 50.0000 (101.9583333d) Dec: +70 14 55.00 (70.24861d) Equinox: J2000		

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Clusters of Galaxies
Description=[Rich clusters]

Template

Module	Subarray
ALL	FULL

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	INTRAMODULEBOX	4	STANDARD		1

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F200W	F480M	SHALLOW4	10	1	4	4	2104.407	

Special Requirements

Aperture PA Range 80 to 285 Degrees (V3 80.0713531 to 285.0713531)
Offset -86.0 arcsec, 0.0 arcsec
Background Limited. Background no more than 40th percentile above minimum

Group Observations 20, 21, 22 within 3 Days

Observation

Proposal 1433, Observation 21: NIRSpec MSA 1

Mon Jan 30 16:01:00 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec MultiObject Spectroscopy

Diagnostics

(Visit 21:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(11)	MACS0647-MSA-TARGETS	RA: 06 47 48.8311 (101.9534629d) Dec: +70 14 11.65 (70.23657d) Equinox: J2000		

Comments:
Description=[]

Acquisition

#	Reference Star Bin	Target	Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	Filter: F110W; Readout: NRSRAPIDD6; 8 sources in 4 quads; [Reduced Accuracy]	SAME	F110W	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	

Template

TA Method	Obtain Confirmation Images	Science Aperture	Primary Candidate List	Filler Candidate List	Spectral Overlap Map	Spectral Overlap Threshold
MSATA	No	MSA Center	MACS0647-MSA-TARGETS (2276 sources)		jwst-nirspec-prism	1.5

Reference Stars

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
1	3248	101.956596	70.238030	22.671	1	5397	101.915564	70.266468	21.409
1	3767	101.973996	70.245266	23.354	1	81922	101.854815	70.254413	23.727
1	4363	101.943341	70.254069	22.697	1	83005	101.991198	70.275161	22.420
1	4455	101.947851	70.255280	23.405	1	83058	101.927582	70.277377	21.894

Spectral Elements

#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
1	1 (PRISM/CLEAR)	c1		101.9446905 Degrees 70.26607388888888 Degrees	305.0518558555126			1	4	3267.911
2	1 (PRISM/CLEAR)	c2		101.9432425 Degrees 70.26614472222222 Degrees	305.0504938601376			1	4	3267.911

Special Requirements	
	On Hold NIRCam pre-imaging required for NIRSpec MSA MSA Scheduled Aperture PA 305.0601197 to 305.0601197 Degrees (V3 166.48555 to 166.48555) 21 After 10 by 60.0 Days to <None specified> Group Observations 20, 21, 22 within 3 Days

Observation

Proposal 1433, Observation 22: NIRSpec MSA 2 Mon Jan 30 16:01:00 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec MultiObject Spectroscopy

Diagnostics

(Visit 22:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(11)	MACS0647-MSA-TARGETS	RA: 06 47 48.8311 (101.9534629d) Dec: +70 14 11.65 (70.23657d) Equinox: J2000		

Comments:
Description=[]

Acquisition

#	Reference Star Bin	Target	Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	Filter: F110W; Readout: NRSRAPIDD6; 8 sources in 3 quads; [Reduced Accuracy]	SAME	F110W	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	

Template

TA Method	Obtain Confirmation Images	Science Aperture	Primary Candidate List	Filler Candidate List	Spectral Overlap Map	Spectral Overlap Threshold
MSATA	No	MSA Center	MACS0647-MSA-TARGETS (2276 sources)		jwst-nirspec-prism	1.5

Reference Stars

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
1	3251	101.993439	70.237932	23.962	1	5459	101.925398	70.267733	22.133
1	3396	101.951785	70.239616	23.937	1	80793	101.880312	70.237710	23.057
1	4260	101.990312	70.252819	23.394	1	81147	102.033698	70.242680	21.838
1	5328	101.931545	70.265472	22.723	1	81922	101.854815	70.254413	23.727

Spectral Elements

#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
1	1 (PRISM/CLEAR)	c1		101.91674516666667 Degrees 70.23458666666667 Degrees	305.0255908091316			1	4	3267.911
2	1 (PRISM/CLEAR)	c2		101.91542545833333 Degrees 70.23471777777777 Degrees	305.0243496365386			1	4	3267.911

Special Requirements	
	On Hold NIRCam pre-imaging required for NIRSpec MSA MSA Scheduled Aperture PA 305.0601197 to 305.0601197 Degrees (V3 166.48555 to 166.48555) 22 After 10 by 60.0 Days to <None specified> Group Observations 20, 21, 22 within 3 Days

Observation

Proposal 1433, Observation 23: NIRSpec MSA 3 Mon Jan 30 16:01:00 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec MultiObject Spectroscopy

Comments: Observation 23 is redoing failed Observation 22
** new roll angle APA*
** 3-slitlet nods*
** "Constrained" Source Centering Constraint used to optimize pointing for 5 primary science targets*
** then "Unconstrained" was used with a small search grid to capture more secondary targets, most of which are extended objects and will yield spectra*
** MSA catalog includes only "Primary" targets (no Fillers) weighted appropriately for science*
** updated reference objects, including more from JWST catalog; only JWST objects are selected by MPT*

Diagnostics

(Visit 23:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(23)	MACS0647-MSA-OBS23	RA: 06 47 50.4007 (101.9600029d) Dec: +70 14 38.12 (70.24392d) Equinox: J2000		

Comments:
Description=[]

Acquisition

#	Reference Star Bin	Target	Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	Filter: CLEAR; Readout: NRSRAPIDD6; 8 sources in 2 quads; [Reduced Accuracy]	SAME	CLEAR	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	

Template

TA Method	Obtain Confirmation Images	Science Aperture	Primary Candidate List	Filler Candidate List	Spectral Overlap Map	Spectral Overlap Threshold
MSATA	No	MSA Center	MACS0647-MSA-OBS23 (3402 sources)		jwst-nirspec-prism	1.5

Reference Stars

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
1	683	101.907533	70.192498	24.068	1	1127	101.889155	70.199562	24.765
1	807	101.916145	70.194527	23.964	1	1806	101.920544	70.211157	24.459
1	994	101.912001	70.197489	24.226	1	1860	101.910190	70.212323	24.902
1	1106	101.884077	70.199333	24.559	1	3066	101.913700	70.234814	24.705

Spectral Elements

#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
1	1 (PRISM/CLEAR)	c1	3 Shutter Slitlet	101.95370070833333 Degrees 70.22521444444445 Degrees	258.1653257964172			3	9	6696.301

Special Requirements	
	On Hold NIRCam pre-imaging required for NIRSpec MSA MSA Scheduled Aperture PA 258.1712197 to 258.1712197 Degrees (V3 119.59665 to 119.59665) 23 After 10 by 60.0 Days to <None specified>