



# 2478 - Spectroscopy of Dwarf Galaxies in the Reionization Era: Ionizing Sources and Gas Conditions at Very Low Metallicity

Cycle: 1, Proposal Category: GO

## INVESTIGATORS

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## OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	rxcj2248-update	NIRSpec MultiObject Spectroscopy	(3) RXCJ2248-UPDATED
	51	rxcj2248-update51	NIRSpec MultiObject Spectroscopy	(5) RXCJ2248-FINAL-obs51
	2	a1703-update	NIRSpec MultiObject Spectroscopy	(4) A1703-FINAL

## ABSTRACT

## JWST Proposal 2478 (Created: Monday, April 3, 2023 at 8:00:44 PM Eastern Standard Time) - Overview

The launch of JWST opens the door for our first window on the stars and gas in the galaxies of the reionization era. The typical galaxies in this early period are low mass star forming systems. The planned Cycle 1 NIRSpec surveys will build large statistical samples of these galaxies, but because of their faintness ( $H=27-29$ ) the spectra will not yield useful insight into their stellar populations or gas conditions. Progress requires coupling the large statistical surveys with extremely deep spectra of low mass galaxies. Here we propose to accomplish this goal via NIRSpec MSA observations of a sample of reionization-era dwarf galaxies that are highly magnified by gravitational lensing. Our primary targets include two  $z>6$  galaxies already known to power strong CIV emission, potentially pointing to a population of extremely low metallicity and very massive stars or the common presence of AGN in dwarf  $z>6$  galaxies. Such intense high ionization nebular emission is unprecedented locally but appears to be a typical feature in the low mass population at these early epochs. The proposed rest-UV to optical spectra will reveal what the high ionization nebular lines are telling us about the ionizing sources and gas conditions in early low mass galaxies. We will simultaneously observe a large number of reionization-era galaxies in the cluster fields, including up to 7 of the brightest ( $H=23.8-25.6$ ) dwarf galaxies known at these redshifts. The proposed spectra will characterize the metallicity, outflows, and ionizing sources in a representative range of low mass  $z>6$  galaxies, providing our most detailed view of the galaxies which are typical in the reionization era.

### **OBSERVING DESCRIPTION**

We propose NIRSpec MSA observations of gravitationally lensed galaxies in two cluster fields, Abell 1703 and RXCJ2248-4431. Our primary targets are two galaxies in these fields with intense CIV emission at  $z=6.11$  and  $z=7.05$ . We will simultaneously target a large number of fainter  $z>4$  galaxies, including up to 8 of the brightest known gravitationally lensed galaxies at  $z>6$ . We will use NIRSpec in its medium resolution ( $R\sim 1000$ ) mode with the goal of ensuring that faint emission lines are not blended. Our goal is to characterize the strength of nebular emission lines from the rest-frame far UV (rest-frame 1500Å) to rest-frame optical (rest-frame 6000Å), requiring spectroscopy across 1 to 5 microns. We will be able to sample the relevant emission lines with two settings in the Abell 1703 field, using G140M/F100LP and G395M/F290LP. In RXCJ2248, we additionally require G235M/F170LP to ensure detection of [OII] in the  $z=6.11$  primary target. Exposure times are set by the need to detect faint emission lines. We require an exposure time of 1.8 hours in G140M, delivering  $SNR>5$  for [OIII] and Si III]. In the redder gratings (G235M, G395M), we require an exposure time of 0.4 hr to detect the fainter lines ([OII], [OIII]4363). For the two fields, this results in 5.0 hrs of science time and 10.0 hrs of charged time

Proposal 2478 - Targets - Spectroscopy of Dwarf Galaxies in the Reionization Era: Ionizing Sources and Gas Conditions at Very Low ...

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	RXCJ2248	RA: 22 48 43.1342 (342.1797258d) Dec: -44 31 58.79 (-44.53300d) Equinox: J2000		
<i>Comments:</i> <i>Description=[]</i>				
(2)	A1703	RA: 13 15 3.2640 (198.7636000d) Dec: +51 49 15.85 (51.82107d) Equinox: J2000		
<i>Comments:</i> <i>Description=[]</i>				
(3)	RXCJ2248-UPDATED	RA: 22 48 43.6911 (342.1820463d) Dec: -44 31 55.64 (-44.53212d) Equinox: J2000		
<i>Comments:</i> <i>Description=[]</i>				
(4)	A1703-FINAL	RA: 13 15 4.0031 (198.7666796d) Dec: +51 49 18.31 (51.82175d) Equinox: J2000		
<i>Comments:</i> <i>Description=[]</i>				
(5)	RXCJ2248-FINAL-obs51	RA: 22 48 42.9628 (342.1790117d) Dec: -44 32 4.17 (-44.53449d) Equinox: J2000		
<i>Comments:</i> <i>Description=[]</i>				

Fixed Targets

Proposal 2478 - Observation 1 - Spectroscopy of Dwarf Galaxies in the Reionization Era: Ionizing Sources and Gas Conditions at Ver...

Tue Apr 04 01:00:44 GMT 2023

<b>Observation</b>	Proposal 2478, Observation 1: rxcj2248-update Diagnostic Status: Warning Observing Template: NIRSpec MultiObject Spectroscopy										
	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.										
<b>Fixed Targets</b>	#	Name	Target Coordinates				Targ. Coord. Corrections			Miscellaneous	
	(3)	RXCJ2248-UPDATED	RA: 22 48 43.6911 (342.1820463d) Dec: -44 31 55.64 (-44.53212d) Equinox: J2000								
<i>Comments: Description=[]</i>											
<b>Acquisition</b>	#	Reference Star Bin	Target	Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	Filter: F140X; Readout: NRSRAPIDD6; 8 sources in 3 quads; [ Optimal TA Accuracy ]	SAME	F140X	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	
<b>Template</b>	TA Method		Obtain Confirmation Images	Science Aperture	Primary Candidate List		Filler Candidate List		Spectral Overlap Map	Spectral Overlap Threshold	
	MSATA		After Target ACQ	MSA Center	primary (27 sources)		secondary (329 sources)		jwst-nirspec-mr	1.5	
<b>Reference Stars</b>	Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude	
	1	1504	342.159527	-44.516424	23.08316993713379	1	2334	342.151001	-44.523937	24.839284896850586	
	1	1830	342.192697	-44.519778	22.401168823242188	1	2725	342.192968	-44.528162	24.22852325439453	
	1	2099	342.158922	-44.522161	23.9202938079834	1	5939	342.178994	-44.559122	22.742171240234374	
	1	2236	342.202294	-44.523132	24.9219970703125	1	6147	342.179690	-44.561879	22.345203314208984	
<b>Confirmation</b>	#	Confirmation Type		Conf. Readout Pattern	Conf. Groups/Int	Conf. Integrations/Exp		Conf. Total Integrations	Conf. Total Exposure Time		
	1	After Target Acq		NRSIRS2	4	1		1	306.367		

Proposal 2478 - Observation 1 - Spectroscopy of Dwarf Galaxies in the Reionization Era: Ionizing Sources and Gas Conditions at Ver...

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 (G140M/F100LP)	c1	3 Shutter Slitlet	342.17360304166 67 Degrees - 44.539915555555 58 Degrees	197.95975178443 555			3	6	6214.867
2		2 (G235M/F170LP)	c1	3 Shutter Slitlet	342.17360304166 67 Degrees - 44.539915555555 58 Degrees	197.95975178443 555			3	3	1575.6
3		3 (G395M/F290LP)	c1	3 Shutter Slitlet	342.17360304166 67 Degrees - 44.539915555555 58 Degrees	197.95975178443 555			3	3	1575.6
Special Requirements	MSA Scheduled Aperture PA 197.9538227 to 197.9538227 Degrees (V3 59.379253 to 59.379253)										

Proposal 2478 - Observation 51 - Spectroscopy of Dwarf Galaxies in the Reionization Era: Ionizing Sources and Gas Conditions at Ve...

Tue Apr 04 01:00:44 GMT 2023

<b>Observation</b>	<b>Proposal 2478, Observation 51: rxcj2248-update51</b> <b>Diagnostic Status: Warning</b> Observing Template: NIRSpec MultiObject Spectroscopy <i>Comments: Repeat of Visit 1:1, which failed due to NIRSpec Short</i>										
	(Visit 51:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.										
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>		
	(5)	RXCJ2248-FINAL-obs51	RA: 22 48 42.9628 (342.1790117d) Dec: -44 32 4.17 (-44.53449d) Equinox: J2000								
<i>Comments: Description=[]</i>											
<b>Acquisition</b>	<b>#</b>	<b>Reference Star Bin</b>	<b>Target</b>	<b>Filter</b>	<b>MSA Configuration</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	Filter: F140X; Readout: NRSRAPIDD6; 8 sources in 3 quads; [ Optimal TA Accuracy ]	SAME	F140X	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	
<b>Template</b>	<b>TA Method</b>		<b>Obtain Confirmation Images</b>	<b>Science Aperture</b>	<b>Primary Candidate List</b>	<b>Filler Candidate List</b>	<b>Spectral Overlap Map</b>	<b>Spectral Overlap Threshold</b>			
	MSATA		After Target ACQ	MSA Center	primary-obs51 (667 sources)	filler-obs51 (2832 sources)	jwst-nirspec-mr	1.5			
<b>Reference Stars</b>	<b>Visit</b>	<b>ID</b>	<b>RA</b>	<b>Dec</b>	<b>Magnitude</b>	<b>Visit</b>	<b>ID</b>	<b>RA</b>	<b>Dec</b>	<b>Magnitude</b>	
	1	1439	342.170686	-44.515351	23.84569931030273	1	2293	342.189148	-44.523695	22.993818283081055	
	1	1504	342.159509	-44.516440	23.08316993713379	1	3987	342.195018	-44.538541	24.185157775878906	
	1	1830	342.192680	-44.519794	22.40116882324218	1	5073	342.183062	-44.549625	23.441143035888672	
	1	2099	342.158911	-44.522185	23.9202938079834	1	15510	342.176582	-44.554782	22.61235809326172	
<b>Confirmation</b>	<b>#</b>	<b>Confirmation Type</b>		<b>Conf. Readout Pattern</b>	<b>Conf. Groups/Int</b>	<b>Conf. Integrations/Exp</b>	<b>Conf. Total Integrations</b>	<b>Conf. Total Exposure Time</b>			
	1	After Target Acq		NRSIRS2	4	1	1	306.367			

Proposal 2478 - Observation 51 - Spectroscopy of Dwarf Galaxies in the Reionization Era: Ionizing Sources and Gas Conditions at Ve...

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 (G140M/F100LP)	c1	3 Shutter Slitlet	342.16646083333 336 Degrees - 44.536483333333 31 Degrees	23.495076453225 433			3	6	6214.867
2		2 (G235M/F170LP)	c1	3 Shutter Slitlet	342.16646083333 336 Degrees - 44.536483333333 31 Degrees	23.495076453225 433			3	3	1575.6
3		3 (G395M/F290LP)	c1	3 Shutter Slitlet	342.16646083333 336 Degrees - 44.536483333333 31 Degrees	23.495076453225 433			3	3	1575.6
Special Requirements	MSA Scheduled Aperture PA 23.4862697 to 23.4862697 Degrees (V3 244.9117 to 244.9117)										

Proposal 2478 - Observation 2 - Spectroscopy of Dwarf Galaxies in the Reionization Era: Ionizing Sources and Gas Conditions at Ver...

Tue Apr 04 01:00:44 GMT 2023

<b>Observation</b>	<b>Proposal 2478, Observation 2: a1703-update</b> <b>Diagnostic Status: Warning</b> Observing Template: NIRSpec MultiObject Spectroscopy										
	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (Visit 2:1) Warning (Form): The recommended value is 8 Reference Stars for this template.										
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>		
	(4)	A1703-FINAL	RA: 13 15 4.0031 (198.7666796d) Dec: +51 49 18.31 (51.82175d) Equinox: J2000			Comments: Description=[]					
<b>Acquisition</b>	<b>#</b>	<b>Reference Star Bin</b>	<b>Target</b>	<b>Filter</b>	<b>MSA Configuration</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	Filter: F140X; Readout: NRSRAPIDD6; 7 sources in 4 quads; [ Optimal TA Accuracy ]	SAME	F140X	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	
<b>Template</b>	<b>TA Method</b>	<b>Obtain Confirmation Images</b>	<b>Science Aperture</b>	<b>Primary Candidate List</b>	<b>Filler Candidate List</b>	<b>Spectral Overlap Map</b>	<b>Spectral Overlap Threshold</b>				
	MSATA	After Target ACQ	MSA Center	a1703-primary-final (673 sources)	a1703-filler-final (1180 sources)	jwst-nirspec-mr	1.5				
<b>Reference Stars</b>	<b>Visit</b>	<b>ID</b>	<b>RA</b>	<b>Dec</b>	<b>Magnitude</b>	<b>Visit</b>	<b>ID</b>	<b>RA</b>	<b>Dec</b>	<b>Magnitude</b>	
	1	528808	198.731102	51.837079	24.9282283782959	1	69238542	198.783794	51.827184	24.92797660827636 7	
	1	5516875	198.742292	51.841716	24.46835899353027 3	1	72587662	198.753482	51.835267	22.47910118103027 3	
	1	9431796	198.728240	51.825580	23.9411563873291	1	86976746	198.802708	51.810428	24.63212394714355 5	
	1	33763630	198.752910	51.797376	24.87281417846679 7						
<b>Confirmation</b>	<b>#</b>	<b>Confirmation Type</b>	<b>Conf. Readout Pattern</b>	<b>Conf. Groups/Int</b>	<b>Conf. Integrations/Exp</b>	<b>Conf. Total Integrations</b>	<b>Conf. Total Exposure Time</b>				
	1	After Target Acq	NRSIRS2	4	1	1	306.367				

Proposal 2478 - Observation 2 - Spectroscopy of Dwarf Galaxies in the Reionization Era: Ionizing Sources and Gas Conditions at Ver...

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 (G140M/F100LP)	c1	3 Shutter Slitlet	198.74882133333 332 Degrees 51.82420194444 45 Degrees	334.20148476196 914			3	6
	2	2 (G395M/F290LP)	c1	3 Shutter Slitlet	198.74882133333 332 Degrees 51.82420194444 45 Degrees	334.20148476196 914			3	3	1575.6
Special Requirements	MSA Scheduled Aperture PA 334.2154997 to 334.2154997 Degrees (V3 195.64093 to 195.64093)										