



1914 - The AURORA Survey: First Direct Metallicity Calibrations at High Redshift

Cycle: 1, Proposal Category: GO

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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	COSMOS_replan-final	NIRSpec MultiObject Spectroscopy	(3) AURORA_COSMOS_inputcat_final
	2	GOODSN_replan-updateID	NIRSpec MultiObject Spectroscopy	(5) AURORA_GOODSN_inputcat_v11

ABSTRACT

We propose the Assembly of Ultradeep Rest-optical Observations Revealing Astrophysics (AURORA) program, which will obtain ultra-deep and continuous R=1000 NIRSpec MSA spectroscopy over the wavelength range 1-5 microns using the G140M/F100LP, G235M/F170LP, G395M/F290LP gratings. We will collect spectra of ~100 galaxies in two carefully chosen pointings, one in each of the COSMOS and GOODS-N extragalactic legacy fields. Target selection will be optimized to obtain the first statistical sample of ~45 $z=1.5-4.0$ galaxies with detectable auroral emission lines enabling direct oxygen abundance estimates. With these measurements, representing an order-of-magnitude increase in the sample of direct oxygen abundances at $z \geq 1.5$, we will construct the first empirical strong-line metallicity calibrations at high redshift. Such calibrations are essential for exploiting the transformative rest-frame optical emission-line datasets to be collected with JWST/NIRSpec out to $z \sim 10$, and measuring actual oxygen abundances rather than simply the ratios of strong nebular emission lines. In turn, measurements of galaxy chemical abundances over cosmic time, in concert with their stellar masses, provide critical constraints on galaxy formation models. Using the proposed ultra-deep near-IR spectroscopic observations, we will also explore the physical properties of gas and stars in $z > 6$ star-forming galaxies during the epoch of reionization, calibrate the nebular attenuation curve during the epoch of peak star formation ($z=1.5-4.0$), and constrain the formation histories of massive, quiescent galaxies.

OBSERVING DESCRIPTION

We propose the Assembly of Ultradeep Rest-optical Observations Revealing Astrophysics (AURORA) program, which will obtain ultra-deep and continuous R=1000 NIRSpec MSA spectroscopy over the wavelength range 1-5 microns for distant galaxies.

Pointings and Sample:

We will collect NIRSpec spectra of ~100 galaxies in two carefully chosen pointings, one in each of the COSMOS and GOODS-N extragalactic legacy fields. Both COSMOS and GOODS-N are already covered by extensive multi-wavelength imaging and spectroscopic datasets, which we will leverage with the proposed NIRSpec observations. Target selection will be optimized to obtain the first statistical sample of ~45 $z=1.5-4.0$ star-forming galaxies with detectable auroral emission lines enabling direct oxygen abundance estimates and the first high-redshift direct abundance calibration. We will also target $z>6$ star-forming galaxies during the epoch of reionization to explore their stellar and gaseous properties; additional star-forming galaxies at $z=1.5-4.0$ to constrain the nebular attenuation curve during the epoch of peak star formation; and, finally massive, quiescent $z>2$ galaxies to constrain their formation histories.

Instrument Modes and Exposure Times:

In each pointing we will collect deep NIRSpec MSA R=1000 spectroscopy using the G140M/F100LP, G235M/F170LP, and G395M/F290LP gratings. Our goal is to reach a 5-sigma emission-line sensitivity of 1×10^{-18} erg/s/cm² across the full 1-5 micron wavelength range, which is the expected flux level of the faint auroral emission lines that we aim to detect in our proposed $z=1.5-4.0$ star-forming galaxy sample. Based on the NIRSpec ETC, we can reach this sensitivity based on 44204/28886/15056 sec (12.3/8.0/4.2 hours) in G140M/F100LP/G235M/F170LP/G395M/F290LP. We will use the NRSIRS2 readout. For G140M/F100LP, we assume 20 groups per integration, 2 integrations for each of the 3 nod positions, and will repeat the nod pattern 5 times. For G235M/F170LP, we assume 13 groups per integration, 2 integrations for each of the 3 nod positions, and will repeat the nod pattern 5 times. For G395M/F290LP, we assume 17 groups per integration, 2 integrations for each of the 3 nod positions, and will repeat the nod pattern 2 times. Our total science integration time is 48.4 hours, which translates to 63.8 hours including overheads.

Proposal 1914 - Targets - The AURORA Survey: First Direct Metallicity Calibrations at High Redshift

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	COSMOS	RA: 10 00 30.2198 (150.1259158d) Dec: +02 20 54.55 (2.34849d) Equinox: J2000		
<i>Comments:</i> <i>Description=[]</i>				
(2)	GOODSN	RA: 12 36 56.6162 (189.2359008d) Dec: +62 14 33.48 (62.24263d) Equinox: J2000		
<i>Comments:</i> <i>Description=[]</i>				
(3)	AURORA_COSMOS_inputcat _final	RA: 10 00 30.0245 (150.1251021d) Dec: +02 21 3.79 (2.35105d) Equinox: J2000		
<i>Comments:</i> <i>Description=[]</i>				
(5)	AURORA_GOODSN_inputca t_v11	RA: 12 36 49.8017 (189.2075071d) Dec: +62 14 44.57 (62.24571d) Equinox: J2000		
<i>Comments:</i> <i>Description=[]</i>				

Fixed Targets

Proposal 1914 - Observation 1 - The AURORA Survey: First Direct Metallicity Calibrations at High Redshift

Wed Oct 11 21:01:02 GMT 2023

Observation	Proposal 1914, Observation 1: COSMOS_replan-final Diagnostic Status: Warning Observing Template: NIRSpec MultiObject Spectroscopy										
	(Visit 1:1) Warning (Form): Data Excess over lower threshold (Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (Visit 1:1) Warning (Form): The recommended value is 8 Reference Stars for this template. (Visit 1:2) Warning (Form): Data Excess over lower threshold (Visit 1:2) Warning (Form): Overheads are provisional until the Visit Planner has been run. (Visit 1:2) Warning (Form): The recommended value is 8 Reference Stars for this template.										
Diagnosics											
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous		
	(3)	AURORA_COSMOS_inputcat_final	RA: 10 00 30.0245 (150.1251021d) Dec: +02 21 3.79 (2.35105d) Equinox: J2000								
<i>Comments:</i> 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: F140X; Readout: NRSRAPID; 6 sources in 4 quads; [Optimal TA Accuracy]	SAME	F140X	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
	2	Filter: F140X; Readout: NRSRAPID; 6 sources in 4 quads; [Optimal TA Accuracy]	SAME	F140X	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
Template	TA Method	Obtain Confirmation Images		Science Aperture	Primary Candidate List	Filler Candidate List	Spectral Overlap Map		Spectral Overlap Threshold		
	MSATA	No		MSA Center	Primary-auroral-cosmos (248 sources)		jwst-nirspec-mr		1.5		
Reference Stars	Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude	
	1	3620	150.144432	2.215794	20.83099934807398	1	7810	150.167979	2.259505	21.585637435696135	
	1	4495	150.145086	2.223489	22.233070928820375	1	7896	150.165547	2.260538	22.946739196777344	
	1	5224	150.180011	2.231272	22.817928864809353	1	7972	150.141066	2.261776	21.342230717729215	
	Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude	
	2	3620	150.144432	2.215794	20.83099934807398	2	7810	150.167979	2.259505	21.585637435696135	
	2	4495	150.145086	2.223489	22.233070928820375	2	7896	150.165547	2.260538	22.946739196777344	
2	5224	150.180011	2.231272	22.817928864809353	2	7972	150.141066	2.261776	21.342230717729215		

Proposal 1914 - Observation 1 - The AURORA Survey: First Direct Metallicity Calibrations at High Redshift

	#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
Spectral Elements	1	1 (G140M/F100LP)	c1	3 Shutter Slitlet	150.15901979166 665 Degrees 2.2423419444444 446 Degrees	71.595854469107 21			3	15	22102.168
	2	1 (G140M/F100LP)	c1	3 Shutter Slitlet	150.15901979166 665 Degrees 2.2423419444444 446 Degrees	71.595854469107 21			3	15	22102.168
	3	2 (G235M/F170LP)	c1	3 Shutter Slitlet	150.15901979166 665 Degrees 2.2423419444444 446 Degrees	71.595854469107 21			3	15	14443.001
	4	2 (G235M/F170LP)	c1	3 Shutter Slitlet	150.15901979166 665 Degrees 2.2423419444444 446 Degrees	71.595854469107 21			3	15	14443.001
	5	3 (G395M/F290LP)	c1	3 Shutter Slitlet	150.15901979166 665 Degrees 2.2423419444444 446 Degrees	71.595854469107 21			3	6	7527.867
	6	3 (G395M/F290LP)	c1	3 Shutter Slitlet	150.15901979166 665 Degrees 2.2423419444444 446 Degrees	71.595854469107 21			3	6	7527.867
Special Requirements	Group Visits within 53.0 Days Visits Same PA MSA Scheduled Aperture PA 71.5946 to 71.5946 Degrees (V3 293.02005 to 293.02005)										

Proposal 1914 - Observation 2 - The AURORA Survey: First Direct Metallicity Calibrations at High Redshift

Wed Oct 11 21:01:02 GMT 2023

Observation	Proposal 1914, Observation 2: GOODSN_replan-updateID Diagnostic Status: Warning Observing Template: NIRSpec MultiObject Spectroscopy										
	(Visit 2:1) Warning (Form): Data Excess over lower threshold (Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (Visit 2:2) Warning (Form): Overheads are provisional until the Visit Planner has been run.										
Diagnosics											
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous		
	(5)	AURORA_GOODSN_inputca t_v11	RA: 12 36 49.8017 (189.2075071d) Dec: +62 14 44.57 (62.24571d) Equinox: J2000								
<i>Comments:</i> 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: F140X; Readout: NRSRAPIDD6; 8 sources in 4 quads; [Optimal TA Accuracy]	SAME	F140X	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	
	2	Filter: F140X; Readout: NRSRAPIDD6; 8 sources in 4 quads; [Optimal TA Accuracy]	SAME	F140X	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	AURORA_GOODSN_inputca at_v11 (566 sources)		jwst-nirspec-mr		1.5		
Reference Stars	Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude	
	1	20457	189.143912	62.242331	22.44664892804218	1	24899	189.124866	62.264045	22.81845517558322	
	1	21552	189.161868	62.247667	23.31025578376139	1	25080	189.219749	62.265077	24.45365201631531	
	1	24531	189.122453	62.262391	23.21848538371101	1	27288	189.148315	62.275843	24.96423547427425	
	1	24843	189.198640	62.263903	23.13295973247190	1	29329	189.180190	62.286600	24.64123809175241	
	2	20457	189.143912	62.242331	22.44664892804218	2	24899	189.124866	62.264045	22.81845517558322	
	2	21552	189.161868	62.247667	23.31025578376139	2	25080	189.219749	62.265077	24.45365201631531	
	2	24531	189.122453	62.262391	23.21848538371101	2	27288	189.148315	62.275843	24.96423547427425	
	2	24843	189.198640	62.263903	23.13295973247190	2	29329	189.180190	62.286600	24.64123809175241	

Proposal 1914 - Observation 2 - The AURORA Survey: First Direct Metallicity Calibrations at High Redshift

	#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
Spectral Elements	1	1 (G140M/F100LP)	c1	3 Shutter Slitlet	189.175955 Degrees 62.265955555555 56 Degrees	69.979275406604 36			3	15	22102.168
	2	1 (G140M/F100LP)	c1	3 Shutter Slitlet	189.175955 Degrees 62.265955555555 56 Degrees	69.979275406604 36			3	15	22102.168
	3	2 (G235M/F170LP)	c1	3 Shutter Slitlet	189.175955 Degrees 62.265955555555 56 Degrees	69.979275406604 36			3	15	14443.001
	4	2 (G235M/F170LP)	c1	3 Shutter Slitlet	189.175955 Degrees 62.265955555555 56 Degrees	69.979275406604 36			3	15	14443.001
	5	3 (G395M/F290LP)	c1	3 Shutter Slitlet	189.175955 Degrees 62.265955555555 56 Degrees	69.979275406604 36			3	6	7527.867
	6	3 (G395M/F290LP)	c1	3 Shutter Slitlet	189.175955 Degrees 62.265955555555 56 Degrees	69.979275406604 36			3	6	7527.867
Special Requirements	Group Visits within 53.0 Days Visits Same PA MSA Scheduled Aperture PA 70.0072 to 70.0072 Degrees (V3 291.4326 to 291.4326)										