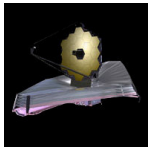

2136 - The emergence of the modern Hubble sequence revealed by JWST slit-stepping

Cycle: 1, Proposal Category: GO

INVESTIGATORS

Name	*Institution*	*E-Mail*
Prof. Tucker Jones (PI)	**University of California - Davis**	**tdjones@ucdavis.edu**
Dr. Ryan Sanders (CoI)	University of California - Davis	rlsand@ucdavis.edu
Dr. Alaina L. Henry (CoI)	Space Telescope Science Institute	ahenry@stsci.edu
Jessie Hirtenstein (CoI)	University of California - Davis	jhirtenstein@ucdavis.edu
Prof. Matthew A. Malkan (CoI)	University of California - Los Angeles	malkan@astro.ucla.edu
Dr. Kasper Borello Schmidt (CoI) (ESA Member)	Leibniz-Institut für Astrophysik Potsdam (AIP)	kbschmidt@aip.de
Prof. Tommaso L. Treu (CoI)	University of California - Los Angeles	tt@astro.ucla.edu
Dr. Xin Wang (CoI)	University of Chinese Academy of Sciences	xwang@ucas.ac.cn
Prof. Karl Glazebrook (CoI)	Swinburne University of Technology	kglazebrook@swin.edu.au
Dr. Takahiro Morishita (CoI)	California Institute of Technology	takahiro@ipac.caltech.edu
Mr. Juan Manuel Espejo (CoI)	Swinburne University of Technology	jespejosalcedo@swin.edu.au

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	PA0_unconstrained_StuckOpenShutters_obs1_primary3_v4	NIRSpec MultiObject Spectroscopy	(2) CAT.LMASSGT9P0.LSFRGT-UPDATED

ABSTRACT

At what redshifts and mass scales does the galaxy population transition from irregular clumpy structures, to ordered thin disks of the modern Hubble sequence? What are the roles of accretion and feedback, which regulate the gas supply and star formation in galaxies, in driving this transition?

Addressing these questions requires kinematic data for galaxies during their formative epochs, via spatially resolved spectroscopy on kpc physical scales. While progress has been made using integral field spectrographs coupled to adaptive optics (AO) systems, these ground-based efforts are limited in both sample size and accessible redshift range. In particular AO systems are unable to reach key diagnostics at the transformative period z~1 when thin disks first emerge. This proposal will chart the kinematics of 40--50 galaxies at z~1, along with resolved star formation and metallicity to understand how the formation of thin disks is governed by gas accretion and feedback.

We propose a novel approach using slit-stepping with the multiplexed NIRSpec MSA to efficiently obtain 3-D spectroscopy for a significant sample, for which the requisite spectral and spatial resolution can only be achieved with JWST's unique capabilities. In contrast to the traditional IFU mode, slit-stepping provides equivalent data with more than 15 times higher efficiency, and is therefore the only suitable approach for building a large sample with JWST! As this represents a pilot application of the slit-stepping methodology with JWST, we commit to publicly releasing processed 3-D datacubes and software tools as a service to the community, to facilitate future programs using this approach.

OBSERVING DESCRIPTION

We propose a multiplexed integral field spectroscopy (IFS) survey of galaxies at z=0.5-1.7 in the EGS field with the NIRSpec MSA, using a slit-stepping methodology to obtain pseudo-IFU datacubes of 40-50 targets on a single MSA configuration. Our targets are selected to span the normal star forming population with stellar mass > 10^9 Msun and SFR > 0.6 Msun/yr. The slit stepping approach is >15 times more efficient than the NIRSpec IFU thanks to the sensitivity and multiplexing capability of the MSA.

Slit-stepping dither pattern:

We propose a slit-stepping pattern with 9 "steps" of 0.2 arcsec (= 1 slitlet width) along the dispersion direction, and 7 dithers of 0.075 arcsec (= 1 bar shadow width) along the cross-dispersion direction. Cross-dispersion steps will eliminate bar shadows and ensure almost perfectly uniform integration time across the resulting pseudo-IFU datacubes. The area is thus 1.8x1.5 arcsec with uniform coverage for a 3-slitlet datacube (or 1.8x2.5 arcsec for a 5-slitlet datacube).

Instrument setup, depth, and exposure times:

We use the G140H grating and F100LP filter to map strong nebular emission lines Halpha, [N II]6548,6584, and [S II]6717,6731 in all targets, as

well as Hbeta and [O III]4959,5007 at z>1 (and [S III]9069,9531 and Paschen lines at z<1). We will use these lines to measure spatially resolved kinematics, metallicity, star formation rate, and BPT ionization diagnostics on 0.1x0.2 arcsecond spatial scales. The high resolution grating is needed to study kinematics.

We require 10-sigma sensitivity to the Halpha emission line at surface brightness = 7x10^(-17) erg/s/cm^2/arcsec^2 within a 0.1x0.2 arcsec spatial element, corresponding to the average surface brightness at the rotation curve turnover radius (= 2.2 R_s) for our targets. Based on the NIRSpec ETC we can reach this sensitivity with 2 hours on-source with G140H/F100LP, via 20 minute exposures per dither position. We use the NRSIRS2 readout mode with 17 groups per integration, and 1 integration at each dither position. The total science time integration time requested is 21.72 hours, translating to 31.67 hours including overheads.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	CAT.LMASSGT9P0.LSFRGT-0P2	RA: 14 19 33.0468 (214.8876950d) Dec: +52 51 21.21 (52.85589d) Equinox: J2000		
Comments: Astrometry is from HST imaging *Description=[]*				
(2)	CAT.LMASSGT9P0.LSFRGT-UPDATED	RA: 14 19 35.5359 (214.8980662d) Dec: +52 51 52.35 (52.86454d) Equinox: J2000		
Comments: *Description=[]*				

Observation

Proposal 2136, Observation 1: PA0_unconstrained_StuckOpenShutters_obs1_primary3_v4 Mon Feb 13 18:03:42 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec MultiObject Spectroscopy

Diagnostics

(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.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	CAT.LMASSGT9P0.LSFRGT-UPDATED	RA: 14 19 35.5359 (214.8980662d) Dec: +52 51 52.35 (52.86454d) 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; 6 sources in 3 quads; [Optimal TA 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	primary_3 (473 sources)	filler_3 (1335 sources)	jwst-nirspec-g140h	1.5

Reference Stars

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
1	5261	215.047666	52.915256	22.31968835	1	10240	215.002401	52.912039	21.89013516
1	5741	215.043445	52.915369	22.6877126	1	16270	215.001646	52.942914	23.73072784
1	6464	215.010945	52.896126	22.27319005	1	18352	214.975478	52.935401	23.79009096

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 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9239077887441	-2.963	-0.429	1	1	1181.7
2	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9238368963639	-2.222	-0.429	1	1	1181.7
3	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92376600416924	-1.481	-0.429	1	1	1181.7
4	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9236952078887	-0.741	-0.429	1	1	1181.7
5	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92362431599975		-0.429	1	1	1181.7
6	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9235534243511 6	0.741	-0.429	1	1	1181.7
7	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9234826285513 7	1.481	-0.429	1	1	1181.7
8	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9234117372588	2.222	-0.429	1	1	1181.7
9	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9233408461418 5	2.963	-0.429	1	1	1181.7
10	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9233345846481	2.963	-0.286	1	1	1181.7
11	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9234054753787 3	2.222	-0.286	1	1	1181.7
12	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9234763662849 4	1.481	-0.286	1	1	1181.7
13	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9235471616989	0.741	-0.286	1	1	1181.7
14	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9236180529611		-0.286	1	1	1181.7

#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
15	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92368894440375	-0.741	-0.286	1	1	1181.7
16	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92375974035082	-1.481	-0.286	1	1	1181.7
17	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92383063216647	-2.222	-0.286	1	1	1181.7
18	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92390152416004	-2.963	-0.286	1	1	1181.7
19	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92389525965068	-2.963	-0.143	1	1	1181.7
20	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92382436804957	-2.222	-0.143	1	1	1181.7
21	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92375347662777	-1.481	-0.143	1	1	1181.7
22	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92368268105091	-0.741	-0.143	1	1	1181.7
23	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92361179000028		-0.143	1	1	1181.7
24	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.923540899127	0.741	-0.143	1	1	1181.7
25	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92347010409088	1.481	-0.143	1	1	1181.7
26	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92339921357088	2.222	-0.143	1	1	1181.7
27	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.92332832323045	2.963	-0.143	1	1	1181.7
28	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.923322061901	2.963		1	1	1181.7

#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
29	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92339295185917	2.222		1	1	1181.7
30	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92346384199 29	1.481		1	1	1181.7
31	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92353463663534	0.741		1	1	1181.7
32	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92360552712483			1	1	1181.7
33	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92367641779487	-0.741		1	1	1181.7
34	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92374721297 77	-1.481		1	1	1181.7
35	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92381810401326	-2.222		1	1	1181.7
36	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92388899523405	-2.963		1	1	1181.7
37	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92388273089 2	-2.963	0.143	1	1	1181.7
38	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92381184005745	-2.222	0.143	1	1	1181.7
39	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92374094940817	-1.481	0.143	1	1	1181.7
40	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92367015461116	-0.741	0.143	1	1	1181.7
41	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92359926432 73		0.143	1	1	1181.7
42	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.92352837422 39	0.741	0.143	1	1	1181.7

#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
43	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9234575799673	1.481	0.143	1	1	1181.7
44	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9233866902197	2.222	0.143	1	1	1181.7
45	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9233158006477	2.963	0.143	1	1	1181.7
46	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9233095394745 3	2.963	0.286	1	1	1181.7
47	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9233804286603	2.222	0.286	1	1	1181.7
48	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9234513180218	1.481	0.286	1	1	1181.7
49	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9235221118929	0.741	0.286	1	1	1181.7
50	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9235930016101 3		0.286	1	1	1181.7
51	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9236638915078 3	-0.741	0.286	1	1	1181.7
52	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9237346859192	-1.481	0.286	1	1	1181.7
53	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9238055761822	-2.222	0.286	1	1	1181.7
54	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9238764666305	-2.963	0.286	1	1	1181.7
55	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9238702024496	-2.963	0.429	1	1	1181.7
56	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.923148888889 Degrees	346.9237993123875	-2.222	0.429	1	1	1181.7

#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
57	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.9237284225106	-1.481	0.429	1	1	1181.7
58	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.9236576284847 6	-0.741	0.429	1	1	1181.7
59	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.9235867389732 6		0.429	1	1	1181.7
60	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.9235158496422	0.741	0.429	1	1	1181.7
61	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.9234450561565 4	1.481	0.429	1	1	1181.7
62	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.9233741671812	2.222	0.429	1	1	1181.7
63	1 (G140H/F100LP)	c3		215.01867016666668 Degrees 52.92314888888889 Degrees	346.9233032783813 5	2.963	0.429	1	1	1181.7

Special Requirements

No Parallel Attachments
MSA Scheduled Aperture PA 346.8274697 to 346.8274697 Degrees (V3 208.2529 to 208.2529)