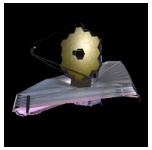

4043 - Unveiling the build-up of large scale structure in the early Universe

Cycle: 2, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
NIRCam Grism				
	1	GRISMobs	NIRCam Wide Field Slitless Spectroscopy	(1) SMACSPROTO

ABSTRACT

Understanding the formation and evolution of the first Large Scale Structure (LSS) of the universe is a key, unsolved question. Early JWST deep surveys have revealed that some of the brightest galaxies identified by the Hubble Space Telescope are in fact surrounded by fainter galaxies, forming protoclusters – the progenitors of the large clusters that we observe in the local Universe. However, both observational and theoretical constraints have until now limited our understanding of star-formation, metal enrichment and feedback processes occurring within these very first structures. NIRCam Wide Field Slitless Spectroscopy (WFSS) observations will allow us for the first time to perform a spectroscopic search, unbiased by selection, for protocluster members. We therefore propose to obtain deep WFSS using the F444W filter covering the SMACS0723 cluster field that contains the previously identified z=7.66 protocluster in order to observe [OIII] and Hb emission in constituent galaxies. This lensed protocluster offers a valuable opportunity to spectroscopically confirm the constituent galaxies of a likely-AGN hosting protocluster. Moreover, we

will constrain their properties allowing us for the first time to understand the evolution of a protocluster through observations of the distribution of star-formation, metallicity and the age of the protocluster shedding unique light on the physical processes governing some of the earliest LSS identified to date.

OBSERVING DESCRIPTION

The primary goal of this proposal is to target [OIII]4959,5007 and Hb emission in candidate galaxies residing in a lensed z = 7.66 candidate protocluster in the SMACS0723 cluster field. These emission lines fall into the F444W filter at z = 7.66. While NIRCam Grism observations can result in an incomplete spectral coverage (loss of the reddest wavelengths in F444W) depending on the position of objects on the modules, given we only require the bluest wavelength coverage in the F444W filter to observe [OIII]5007 and Hb emission lines at z = 7.66, we will be unaffected by any incomplete spectral coverage. Regarding our proposed setup, we require only 1 pointing to observe the full spatial extent of the protocluster, most of the pre-existing detector gap and the critical lines. Regarding dithering parameters, we request an INTRAMODULEBOX dithering pattern in order to cover both NIRCam SW modules without gaps at the deepest exposure possible. We propose to use the NIRCam FULL subarray and a 4 point dither in order to ensure good sampling of both extended and point-source objects in the field. We do not require sub-pixel dithering as we do not request parallel observations. We will perform spectroscopy with both the R and C Grisms in order to ensure the emission lines from protocluster constituent galaxies are not severely contaminated. Combining R and C Grism observations will ensure this does not occur as we will be able to remove contaminating sources from the final extracted spectrum.

We aim to achieve a > 6.5-sigma detection of [OIII]5007 in the 6 brightest protocluster constituents (we estimate f[OIII]5007 > 4 × 10^-18 erg s^-1 cm^-2 using known estimates of [OIII] flux from UV magnitude ratios), while for the two remaining faint candidates [OIII]5007 should be detected at ~ 2-sigma allowing us to stack faint candidates and produce confirmation of an underlying faint [OIII]5007 emitting population. We use the Exposure Time Calculator to confirm that this is possible using a setup of a MEDIUM2 readout pattern, the maximum number of groups per integration of 10 and 2 integrations per exposure, repeated twice with the two different SW filters requested (see Workbook ID: 141617). This results in a total of 16 integrations with a total exposure time for the WFSS in F444W of 15890 seconds.

We additionally propose to use the simultaneous SW imaging to obtain F090W F115W imaging. In combination with the existing F090W imaging to allow us to probe down to a 2-sigma limiting magnitude of ~30.6, and even deeper when accounting for magnification, where the FOV of the two observations overlap. Additionally, previous observations of the field do not include F115W imaging. These two SW images will be completed by splitting the 16 integration required for the LW WFSS into two SW imaging campaigns in the two SW filters desired.

Finally, we additionally require direct imaging in the F444W filter in order to match all spectra identified in the NIRCam LW Grism observations to sources. While there is pre-existing F444W imaging, our positioning of the NIRCam instrument means we are imaging a new area north of the pre-existing observations that will require this direct imaging to identify sources. We need to be able to identify all protocluster-constituent galaxies in the F444W direct image. We therefore ensure that we are able to observe all candidates reported in Laporte et al. (2022) at 5-sigma and hence require a 5-sigma limiting magnitude in the F444W direct image of 28.7 mag. We find using the ETC that we are able to achieve this using a MEDIUM2 readout pattern with 10 groups per integration, 4 integrations and 1 dither (see Workbook ID: 144932). These 4 integrations total 3983 seconds of integration time as well as 7967 seconds of out of field integration time. The total exposure time of this proposal is therefore ~ 15 hours, leading to 19.89 hours after overheads.

Proposal 4043 - Targets - Unveiling the build-up of large scale structure in the early Universe

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	SMACSPROTO	RA: 07 23 13.6620 (110.8069250d) Dec: -73 27 25.59 (-73.45711d) Equinox: J2000		

Comments:
Category=Galaxy
Description=[Emission line galaxies, High-redshift galaxies, Interacting galaxies]

Observation

Proposal 4043, Observation 1: GRISMobs Thu May 11 13:10:44 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRCam Wide Field Slitless Spectroscopy

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)	SMACSPROTO	RA: 07 23 13.6620 (110.8069250d) Dec: -73 27 25.59 (-73.45711d) Equinox: J2000		

Comments:
Category=Galaxy
Description=[Emission line galaxies, High-redshift galaxies, Interacting galaxies]

Template

Module	Subarray	Grism (Long Wavelength)
ALL	FULL	BOTH

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Positions
1	INTRAMODULEBOX	4	NONE

Direct Image

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	Grism (Long Wavelength)	Exposure Type	Total Dithers
1	F115W	F444W	MEDIUM2	10	4	4	3983.342	144932	GRISMR	Direct Image	1
2	F115W	F444W	MEDIUM2	10	4	4	3983.342	144932	GRISMC	Direct Image	1

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	Grism (Long Wavelength)	Exposure Type	Total Dithers
1	F090W	F444W	MEDIUM2	10	2	8	7945.21	141617	GRISMR	Grism (Long Wavelength)	4
2	F115W	F444W	MEDIUM2	10	2	8	7945.21	141617	GRISMR	Grism (Long Wavelength)	4
3	F115W	F444W	MEDIUM2	10	4	8	7966.683	144932		Out of Field	2
4	F090W	F444W	MEDIUM2	10	2	8	7945.21	141617	GRISMC	Grism (Long Wavelength)	4
5	F115W	F444W	MEDIUM2	10	2	8	7945.21	141617	GRISMC	Grism (Long Wavelength)	4
6	F115W	F444W	MEDIUM2	10	4	8	7966.683	144932		Out of Field	2

Special Requirements	
	Aperture PA Range 105 to 125 Degrees (V3 105.0 to 125.0) Background Limited. Background no more than 10th percentile above minimum