



7573 - The first complete picture of the star-formation cycle at $z=1$ from molecular clouds to star cluster complexes

Cycle: 4, Proposal Category: GO

INVESTIGATORS

<i>Name</i>	<i>Institution</i>
Dr. Miroslava Dessauges-Zavadsky (PI) (ESA Member)	University of Geneva, Department of Astronomy
Dr. Matteo Messa (CoI) (ESA Member) (CoPI)	INAF - OAS Bologna
Dr. Johan Pierre Richard (CoI) (ESA Member)	Centre de Recherche Astrophysique de Lyon
Dr. Angela Adamo (CoI) (ESA Member)	Stockholm University
Dr. Adelaide Marie Claeysens (CoI) (ESA Member)	Stockholm University
Prof. Daniel Schaerer (CoI) (ESA Member)	University of Geneva, Department of Astronomy
Dr. Francoise Combes (CoI) (ESA Member)	Observatoire de Paris
Dr. Lucio Mayer (CoI) (ESA Member)	Universitat Zurich
Dr. Gabriel Brammer (CoI) (ESA Member)	University of Copenhagen, Niels Bohr Institute
Dr. Eiichi Egami (CoI) (US Admin CoI)	University of Arizona
Dr. Mengyuan Xiao (CoI) (ESA Member)	University of Geneva, Department of Astronomy

OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
NIRSpec IFU				
	1		NIRSpec IFU Spectroscopy	(1) A521-SYS1
NIRCam imaging				
	3		NIRCam Imaging	(1) A521-SYS1

ABSTRACT

JWST Proposal 7573 (Created: Tuesday, March 11, 2025, 4:01:46PM Eastern Standard Time) - Overview

Galaxies at $z \sim 1-3$ host UV-bright clumps, recognised as star cluster complexes formed via disk fragmentation. A521-sys1, a strongly lensed galaxy at $z=1$, resolved down to 30 pc, sets a record in hosting both 13 stellar clumps detected in HST rest-UV images and 14 giant molecular clouds (GMCs) detected in ALMA CO data at matched $\sim 0.1''$ resolution. The comparison of GMC and UV clump masses suggests so far a star formation efficiency of 30%, much higher than in local GMCs ($< 6\%$). This is a striking result that needs to be confirmed with the requested NIRSpec-IFU Ha mapping of A521-sys1 that will spatially ($\sim 0.1''$) cross-match GMCs with Ha clumps tracing star formation at much shorter timescales than UV emission. If confirmed, this would suggest an increase in the efficiency of forming stars in high- z galaxies, as advocated by several JWST discoveries. NIRSpec-IFU observations will further reveal: clump metallicities (from $\text{Ha}+[\text{NII}]$) to be compared to the underlying disk metallicity; clump outflow signatures and contribution to the stellar feedback at galactic scale; and spatial variations of the Toomre instability (when combined with ALMA CO) to be correlated with stellar clump and GMC locations. The requested NIRCам rest-optical images will determine clump ages and solve the long-standing debate on clump survival timescale as transient features or long-lived star-forming regions. NIRCам will also evidence old, dust extincted or embedded clumps (if any) missed by HST. Our JWST observations will provide the complete picture of the star-formation cycle in this $z=1$ galaxy from GMCs to star cluster complexes and nail how clumps contribute to the overall evolution of the host galaxy.

OBSERVING DESCRIPTION

We request for NIRSpec-IFU spectroscopy imaging of the strongly lensed galaxy A521-sys1 at $z=1$, magnified by the foreground galaxy cluster Abell 521. The goal is to measure spatially resolved H α emission at 0.1" FWHM resolution across the detected UV-bright stellar clumps and giant molecular clouds. A mosaic of two pointing is needed to cover the main multiple images of the A521-sys1 arc. The NIRSpec observations are taken in G140H/F100LW with 2 integrations per exposure and 10 groups (for each pointing). The selected detector setup is NRSIRS2 and a 8-point medium cycling dithering pattern is used. No background subtraction is performed. The corresponding exposure time allows us to detect H α emission at $\text{SNR} > 5$ (peak wavelength, 0.3 arcsec diameter aperture for a point source in the faintest clumps), while also recovering H β and [NII] emissions for the brightest clumps. We require a specific range of PA to optimise the orientation of the IFU with the elongation of the A521-sys1 arc.

We also request NIRCам imaging with the F140M, F150W, F277W and F356W filters with specific offsets to have the A521-sys1 arc centered within one of the NIRCам-SW chip. We use a MEDIUM8 readout pattern, 4 dither positions and 8 group per integration. The corresponding exposure times allows to reach $\text{SNR} > 5$ in the two filters for fainter magnitudes than HST-detected clumps ($\text{ABmag} > 28.5$), allowing the study of clumps down to the intrinsic sizes (~ 10 pc) and masses ($\sim 10^6 M_{\text{sun}}$) of individual stellar clusters of all possible ages (up to a few $\sim \text{Gyr}$). We request a range of position angles that allow one of the modules to cover the more central regions of the cluster, important for the legacy value of the observations.

Proposal 7573 - Targets - The first complete picture of the star-formation cycle at z=1 from molecular clouds to star cluster complexes

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	A521-SYS1	RA: 04 54 6.6080 (73.5275333d)	Epoch of Position: 2015.5	
Dec: -10 13 21.33 (-10.22259d)					
Equinox: J2000					
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Coordinates were adjusted using WFC3 images from the HLA. Category=Galaxy Description=[High-redshift galaxies]</i>					

Proposal 7573 - Observation 1 - The first complete picture of the star-formation cycle at z=1 from molecular clouds to star cluster com...

Tue Mar 11 21:01:46 GMT 2025

Observation	Proposal 7573, Observation 1 Diagnostic Status: Warning Observing Template: NIRSspec IFU Spectroscopy <i>Comments: A PA range requirement has been added to make sure that the IFU mosaic follow the extent of the lensed arc, and therefore that the coverage of Ha clumps is maximised.</i>											
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)	A521-SYS1	RA: 04 54 6.6080 (73.5275333d) Dec: -10 13 21.33 (-10.22259d) Equinox: J2000			Epoch of Position: 2015.5							
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Coordinates were adjusted using WFC3 images from the HLA. Category=Galaxy Description=[High-redshift galaxies]</i>												
Template	TA Method						HFF Readout Mode					
NONE						false						
Mosaic	Rows	Columns	Row Overlap %	Column Overlap %	Row shift (deg)	Column shift (deg)	Tile Order					
2	1	10.0	10.0	0.0	0.0	DEFAULT						
Dithers	#	Dither Type		Size	Starting Point		Number of Points		Points			
1	CYCLING		MEDIUM	1		8						
Spectral Elements	#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G140H/F100LP	NRSIRS2	10	2	false	true	NONE	8	16	11904.534		

Proposal 7573 - Observation 1 - The first complete picture of the star-formation cycle at z=1 from molecular clouds to star cluster com...

Special Requirements

Aperture PA Range 26.97164917 to 44.97164917 Degrees (V3 248.0 to 266.0)
Aperture PA Range 206.97164917 to 224.97164917 Degrees (V3 68.0 to 86.0)

Proposal 7573 - Observation 3 - The first complete picture of the star-formation cycle at z=1 from molecular clouds to star cluster com...

Tue Mar 11 21:01:46 GMT 2025

Observation	<p>Proposal 7573, Observation 3</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCam Imaging</p> <p><i>Comments: An offset has been introduced in order to keep the targeted lensed galaxy at the centre of one of the detectors at any PA. We request a range of position angles that allow one of the modules to cover the more central regions of the cluster, which have an important legacy value.</i></p>									
Diagnostics	(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections			Miscellaneous		
	(1)	A521-SYS1	RA: 04 54 6.6080 (73.5275333d) Dec: -10 13 21.33 (-10.22259d) Equinox: J2000		Epoch of Position: 2015.5					
	<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Coordinates were adjusted using WFC3 images from the HLA. Category=Galaxy Description=[High-redshift galaxies]</i></p>									
Template	Module		Subarray			Target Placement				
	ALL		FULL			Module Gap				
Dithers	#	Primary Dither Type		Primary Dithers		Subpixel Dither Type		Dither Size		Subpixel Positions
	1	NONE				STANDARD				4
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	F150W	F277W	MEDIUM8	8	1	4	4	3349.872	
	2	F140M	F356W	MEDIUM8	8	1	4	4	3349.872	
Special Requirements	<p>Aperture PA Range 9.9286469 to 84.9286469 Degrees (V3 10.00322384 to 85.00322384) Offset 120.0 arcsec, 35.0 arcsec</p>									