



# 9411 - Probing cold gas, dust, and stars to solve the quenching puzzle in Jekyll and Hyde

Cycle: 4, Proposal Category: GO

## INVESTIGATORS

<i>Name</i>	<i>Institution</i>
<b>Dr. Michele Perna (PI) (ESA Member)</b>	<b>Centro de Astrobiologia - CAB</b>
Dr. Francesco D'Eugenio (CoI) (ESA Member)	University of Cambridge, Kavli Institute for Cosmology
Dr. Isabella Lamperti (CoI) (ESA Member)	Universita di Firenze
Prof. Santiago Arribas (CoI) (ESA Member)	Consejo Superior de Investigaciones Cientificas
Dr. Giacomo Venturi (CoI) (ESA Member)	Scuola Normale Superiore, Pisa
Dr. Gareth C Jones (CoI) (ESA Member)	University of Cambridge
Dr. Hannah Uebler (CoI) (ESA Member)	Max Planck Institute for Extraterrestrial Physics
Dr. Bruno Rodriguez Del Pino (CoI) (ESA Member)	Centro de Astrobiologia - CAB
Dr. Mirko Curti (CoI) (ESA Member)	INAF - Astrophysics and Space Science Observatory
Dr. Elena Bertola (CoI) (ESA Member)	INAF - Osservatorio Astrofisico di Arcetri
Prof. Stefano Carniani (CoI) (ESA Member)	Scuola Normale Superiore, Pisa
Prof. Pablo G. Perez Gonzalez (CoI) (ESA Member)	Centro de Astrobiologia - CAB
Prof. Andrew Bunker (CoI) (ESA Member)	University of Oxford
Prof. Roberto Maiolino (CoI) (ESA Member)	University of Cambridge
Dr. Chiara Circosta (CoI) (ESA Member)	Institut de Radioastronomie Millimetrique
Dr. Giovanni Cresci (CoI) (ESA Member)	INAF - Osservatorio Astrofisico di Arcetri

## OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	Jekyll	NIRSpec IFU Spectroscopy	(1) Jekyll

## **ABSTRACT**

2025.1.01246.S

We request deep ALMA Band 8 observations and JWST/NIRSpec IFS (R100) data of the Jekyll and Hyde system at  $z=3.7$ , which includes a massive quiescent galaxy (Jekyll), a post-starburst galaxy (Hyde), and three newly discovered gas-rich components (Eastfield, Mr West, and Dr Sodium) with ambiguous nature. We aim to identify the physical drivers of early quenching in this system. ALMA will detect [CII]158 $\mu\text{m}$  and dust continuum with 6x greater depth than previous data, crucially reaching the sensitivity required to trace cold gas and dust (or exclude their presence) in the newly discovered satellites. The requested NIRSpec data will map stellar populations across Jekyll, Hyde, and the gas-rich structures. Together, these observations will allow us to identify the processes driving the Hyde transition from starburst to quiescent, to investigate whether Jekyll retains cold gas and dust, whether Eastfield and Mr West are AGN-hosting satellites or gas clouds ejected by AGN feedback, and whether Dr Sodium is part of Hyde's disc or an outflow. This joint programme will offer a decisive view into the interplay between AGN, cold gas and dust, and environment of early massive galaxy quenching.

## **OBSERVING DESCRIPTION**

We request 10 hours of on-source integration with JWST/NIRSpec Integral Field Spectroscopy (IFS) in the low-resolution R100 mode to map the rest-frame optical stellar continuum and emission lines across the Jekyll and Hyde system at  $z = 3.7$ , including the faint, gas-rich components Eastfield, Mr. West, and Dr. Sodium (as identified in Perez-Gonzalez et al. 2025, NatAs, 9, 1240). This represents a tenfold increase over existing archival R100 data, which comprise only 1 hour of integration.

The deeper exposure will enhance the signal-to-noise ratio (S/N) by a factor of  $\sim 3$ , enabling robust detection and spatially resolved analysis of the stellar continuum and line features in these components. This is essential to (i) unveil the nature of Eastfield and Mr West, distinguishing between low-mass AGN-hosting satellites and ejected gas resulting from prior AGN feedback in Hyde; (ii) unveil the origin of Dr Sodium and understand whether it is part of the extended rotating disc of Hyde or an outflow launched by Jekyll; (iii) expand the stellar population fitting analysis to the low-surface-brightness outskirts of Jekyll; (iv) resolve for the first time stellar population gradients in Hyde.

NIRSpec field of view of  $\sim 3 \times 3$  arcsec<sup>2</sup> fully encompasses the Jekyll and Hyde system, allowing simultaneous observation of all components within a single pointing. The R100 mode's broad wavelength coverage (0.6-5.3  $\mu\text{m}$ ) is particularly suited for capturing both continuum and key emission lines necessary for comprehensive analysis. Photometric data alone are insufficient to achieve our scientific goals, as we need to disentangle stellar continuum from nebular emission, enabling accurate assessments of stellar population and gas conditions across the system.

No background exposures are required since each observation contains a sufficient number of spaxels free from emission from the central source or neighbors, and we will use spaxels within the IFS FoV free from line and continuum emission to perform a background subtraction. Through our dither strategy and carefully determined PA constraints, we minimize the potential impact of MSA leakage, and therefore do not require leakcal exposures.

These observations are critical for interpreting the deep ALMA Band 8 data requested in this joint proposal. The combination of cold gas, dust, ionized gas, and resolved stellar population maps will uniquely constrain quenching mechanisms in Jekyll, AGN feedback from Hyde, and potential environment-driven processes due to interactions among these components within a  $\sim 15 \times 15$  kpc<sup>2</sup> region.

The total requested JWST time, including overheads, is 12.9 hours, as calculated using the JWST Astronomer's Proposal Tool (APT).

Proposal 9411 - Targets - Probing cold gas, dust, and stars to solve the quenching puzzle in Jekyll and Hyde

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	Jekyll	RA: 10 00 14.7600 (150.0615000d) Dec: +02 22 43.30 (2.37869d) Equinox: J2000	Epoch of Position: 2000	
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=Galaxy Description=[High-redshift galaxies, Starburst galaxies]					

Proposal 9411 - Observation 1 - Probing cold gas, dust, and stars to solve the quenching puzzle in Jekyll and Hyde

Wed Jan 28 20:00:14 GMT 2026

<b>Observation</b>	<p><b>Proposal 9411, Observation 1: Jekyll</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRSpec IFU Spectroscopy</p> <p><i>Comments: PA ranges to avoid possible MSA leakage form bright star (Kmag = 8)</i></p>											
<b>Diagnostics</b>	(Visit 1:1) 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>			
	(1)	Jekyll	RA: 10 00 14.7600 (150.0615000d) Dec: +02 22 43.30 (2.37869d) Equinox: J2000			Epoch of Position: 2000						
	<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>Category=Galaxy</i></p> <p><i>Description=[High-redshift galaxies, Starburst galaxies]</i></p>											
<b>Template</b>	<b>TA Method</b>						<b>HFF Readout Mode</b>					
	NONE						false					
<b>Dithers</b>	<b>#</b>	<b>Dither Type</b>		<b>Size</b>	<b>Starting Point</b>		<b>Number of Points</b>	<b>Points</b>				
	1	CYCLING		MEDIUM	1		24					
<b>Spectral Elements</b>	<b>#</b>	<b>Grating/Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Leakcal</b>	<b>Dither</b>	<b>Autocal</b>	<b>Total Dithers</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>Optional ETC ID</b>
	1	PRISM/CLEAR	NRSIRS2	20	1	false	true	NONE	24	24	35363.469	
<b>Special Requirements</b>	Aperture PA Range 138.97164917 to 298.97164917 Degrees (V3 0.0 to 160.0)											