



12159 - The geometry of the Universe seen by JWST through a rare small lens with six multiply imaged sources

Cycle: 5, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
NIRCam SDSSJ0100				
	1		NIRCam Imaging	(3) SDSS-J0100_lensing_system
NIRSpec IFU D4				
	2		NIRSpec IFU Spectroscopy	(2) D1
NIRSpec IFU BGG				
	3		NIRSpec IFU Spectroscopy	(1) SDSS-J010049.18+181827.7_BGG

ABSTRACT

In the LambdaCDM cosmological model, the Universe is composed of 30% of baryons and DM ($\Omega_m=0.3$) and of 70% of the unknown Dark Energy, characterized by an equation-of-state parameter $w=-1$. Recent results have challenged this scenario, finding values of $w>-1$ which radically change the way the Universe has expanded over cosmic times. However, these parameters show degeneracies when probed with standard methods,

and independent, purely geometrical measurements are essential to test the robustness of the cosmological models.

Strong lensing systems in which several sources at different redshifts are multiply lensed by the same deflector represent a solid, alternative probe to test the current tensions. The ideal systems are group-scale lenses, whose mass can be modeled with a few parameters.

We propose pioneering NIRSpec IFU ($R \sim 1000$) and NIRCам observations of SDSSJ0100, a unique group at $z \sim 0.6$ dominated by a central brightest group galaxy (BGG), which acts as a gravitational lens on five background sources at three different redshifts.

With the required observations, we will be able to spectroscopically confirm the sixth lensed source, to constrain the internal kinematics of the BGG and investigate the possible presence of one of the most massive black holes known at mid- z in its center, and to photometrically select additional multiply imaged sources at higher redshift.

With this key information, we will build an extended lensing+dynamics model which will allow us to break degeneracies usually affecting strong lensing studies, and to independently measure the values of the cosmological parameters with an accuracy competitive with that from other standard techniques.

OBSERVING DESCRIPTION

Our proposal is composed of three observations. Combined, they will allow us to measure the value of the cosmological parameters Ω_m and w with an accuracy competitive with that from other standard techniques. We will use of a single, extremely rare, lensing system.

In particular, our observations target SDSS J0100+1818, a group of galaxies dominated by a central brightest group galaxy (BGG). It acts as a lens for five spectroscopically-confirmed background sources, at three different redshifts. Our three observations will:

- 1: [NIRSpec IFU]: spectroscopically confirm the sixth lensed source, called D. We will target D1, which is brightest multiple image. The non detection of lines in MUSE and the preliminary lensing models narrow its redshift between 1.5 and 2.6. The G140M/F100LP ($R \sim 1000$) setup will cover the H β , [OIII] and H α lines, detectable down to $2e-18$ erg/s/cm 2 (i.e., $SFR > 1 M_{\odot}/yr$) at 5 sigma.
- 2: [NIRSpec IFU]: measure the inner kinematics of the BGG. We will use NIRSpec's exquisite spatial resolution to measure the stellar velocity dispersion of the inner parts of the BGG, complementing the one in the outer regions (with lower spatial resolution) obtained with MUSE. It will allow us to develop a joint lensing+dynamics model, which breaks the mass-anisotropy degeneracy affecting lensing. Moreover, given the large mass of the BGG, we will be able to investigate the presence of one of the most massive supermassive black holes in its center. it would be one of the most massive known at $z \sim 0.6$.
- 3: [NIRCам Imaging]: study the larger-field environment, and photometrically identify candidate new families of multiple images at higher- z . Color

JWST Proposal 12159 (Created: Friday, March 13, 2026, 5:07:33PM Eastern Standard Time) - Overview

analyses, which are currently not feasible because of the coverage with a single HST filter, are key in lensing studies, and will allow us to photometrically analyse both the deflector and the lensed sources. We will observe in the F200W (Short Wavelength) and F444W (Long Wavelength), reaching a magnitude limit of 28.3 at 5sigma, 2 mag deeper than current HST photometry.

Proposal 12159 - Targets - The geometry of the Universe seen by JWST through a rare small lens with six multiply imaged sources

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	SDSS- J010049.18+181827.7_BGG	RA: 01 00 49.1907 (15.2049612d) Dec: +18 18 27.74 (18.30771d) Equinox: J2000	Proper Motion RA: 8.1 mas/yr Proper Motion Dec: -0.329999889350147 mas/yr Epoch of Position: 2000	
<p><i>Comments: Central Brightest Group Galaxy (BGG) acting as a lens for at least 5 background sources. It has $m_{AB}(R) \sim 17$</i></p> <p><i>This object was generated by the targetselector and retrieved from the SIMBAD database. SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.</i></p> <p><i>Category=Galaxy</i> <i>Description=[Elliptical galaxies]</i> <i>Extended=YES</i></p>				
(2)	D1	RA: 01 00 49.4196 (15.2059150d) Dec: +18 18 22.57 (18.30627d) Equinox: J2000	Epoch of Position: 2000	
<p><i>Comments: Background source at $1.5 < z < 2.5$. We target the brightest multiple image, which shows an extended tail.</i></p> <p><i>Category=Galaxy</i> <i>Description=[Emission line galaxies, High-redshift galaxies]</i></p>				
(3)	SDSS-J0100_lensing_system	RA: 01 00 50.7664 (15.2115267d) Dec: +18 18 39.65 (18.31101d) Equinox: J2000	Proper Motion RA: 8.1 mas/yr Proper Motion Dec: -0.329999889350147 mas/yr Epoch of Position: 2000	
<p><i>Comments: Group-scale gravitational lensing system, dominated by a central massive elliptical galaxy at $z=0.581$</i></p> <p><i>This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.</i></p> <p><i>Category=Galaxy</i> <i>Description=[Elliptical galaxies]</i> <i>Extended=YES</i></p>				

Fixed Targets

Proposal 12159 - Observation 1 - The geometry of the Universe seen by JWST through a rare small lens with six multiply imaged sour...

Fri Mar 13 22:07:34 GMT 2026

Observation	Proposal 12159, Observation 1 Diagnostic Status: Warning Observing Template: NIRCam Imaging									
	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous	
	(3)	SDSS-J0100_lensing_system	RA: 01 00 50.7664 (15.2115267d) Dec: +18 18 39.65 (18.31101d) Equinox: J2000			Proper Motion RA: 8.1 mas/yr Proper Motion Dec: -0.3299999889350147 mas/yr Epoch of Position: 2000				
<i>Comments: Group-scale gravitational lensing system, dominated by a central massive elliptical galaxy at $z=0.581$</i> <i>This object was generated by the targetselector and retrieved from the SIMBAD database.</i> <i>SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.</i> <i>Category=Galaxy</i> <i>Description=[Elliptical galaxies]</i> <i>Extended=YES</i>										
Template	Module		Subarray			Target Placement				
	ALL		FULL			Module B center (small extended source)				
Dithers	#	Primary Dither Type		Primary Dithers		Subpixel Dither Type		Dither Size	Subpixel Positions	
	1	INTRAMODULEBOX		4		SMALL-GRID-DITHER			1	
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	Optional ETC ID
	1	F200W	F444W	MEDIUMDEEP8	5	1	4	4	2920.401	

Special Requirements

Fiducial Point Override NRCBS_FULL

Proposal 12159 - Observation 2 - The geometry of the Universe seen by JWST through a rare small lens with six multiply imaged sour...

Fri Mar 13 22:07:34 GMT 2026

Observation	Proposal 12159, Observation 2 Diagnostic Status: Warning Observing Template: NIRSpec IFU Spectroscopy											
	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous			
	(2)	D1	RA: 01 00 49.4196 (15.2059150d) Dec: +18 18 22.57 (18.30627d) Equinox: J2000			Epoch of Position: 2000						
<i>Comments: Background source at 1.5<z<2.5. We target the brightest multiple image, which shows an extended tail.</i> Category=Galaxy Description=[Emission line galaxies, High-redshift galaxies]												
Template	TA Method						HFF Readout Mode					
	NONE						false					
Dithers	#	Dither Type		Size	Starting Point		Number of Points		Points			
	1	CYCLING		SMALL	1		3					
Spectral Elements	#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	Optional ETC ID
	1	G140M/F100LP	NRSIRS2	17	5	false	true	NONE	3	15	18819.668	

Proposal 12159 - Observation 3 - The geometry of the Universe seen by JWST through a rare small lens with six multiply imaged sour...

Fri Mar 13 22:07:34 GMT 2026

Observation	Proposal 12159, Observation 3 Diagnostic Status: Warning Observing Template: NIRSpec IFU Spectroscopy											
	(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)	SDSS- J010049.18+181827.7_BGG	RA: 01 00 49.1907 (15.2049612d) Dec: +18 18 27.74 (18.30771d) Equinox: J2000	Proper Motion RA: 8.1 mas/yr Proper Motion Dec: -0.3299999889350147 mas/yr Epoch of Position: 2000								
<i>Comments: Central Brightest Group Galaxy (BGG) acting as a lens for at least 5 background sources. It has m_AB (R) ~17</i> <i>This object was generated by the targetselector and retrieved from the SIMBAD database. SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.</i> Category=Galaxy Description=[Elliptical galaxies] Extended=YES												
Template	TA Method						HFF Readout Mode					
	NONE						false					
Dithers	#	Dither Type		Size	Starting Point		Number of Points		Points			
	1	CYCLING		SMALL	1		4					
Spectral Elements	#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	Optional ETC ID
	1	G140M/F100LP	NRSIRS2	9	1	false	true	NONE	4	4	2684.356	