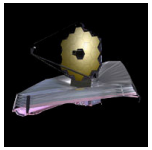

11144 - Unveiling the Mysteries of the warm Neptune GJ 436b: Probing the atmospheric composition and interior properties

Cycle: 5, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	GJ 436b (F322W2+DHS)	NIRCam Grism Time Series	(1) GJ-436
	2	GJ 436b (F444W+DHS)	NIRCam Grism Time Series	(1) GJ-436

ABSTRACT

Warm Neptune-sized exoplanets exhibit compositional diversity and pose several intriguing open questions, including the missing methane detection at temperatures where it should be abundant. GJ 436b is a prime target for detail characterization through transmission spectroscopy to fully understand the missing methane problem. As recent JWST data revealed a low CH4 abundance in WASP-107 b attributed to tidal heating, it is essential to determine whether GJ 436 b shares similar characteristics. With a high atmospheric metallicity and an optimal TSM (>500), it offers ideal conditions for benckmarking against its inflated counterpart, WASP-107 b, to better understand the role of tidal heating. Here, we propose to use NIRCam long-wavelength Grism F322W2 and F444W to observe GJ 436b for two transits with each filter. We will use a Bayesian retrieval framework to determine the atmospheric compostion and planet's properties,supported by forward models incorporating photochemistry and atmospheric mixing. We expect to constrain the abundances of CH4, CO2, and SO2 within 1 dex based on about 25 ppm-level noise in our simulation. Crucially, constraining CH4 and CO2 will help break the degeneracy between metallicity and internal heating, with vertical mixing futher inferred by SO2. This proposed observation, in collaboration with the GTO eclipse programs that probe different atmospheric regions, will leverage the full power of JWST to address the missing methane mystery and sulfur photochemistry.

OBSERVING DESCRIPTION

We will use NIRCam to observe GJ 436b with two long-wavelength filters, NIRCam F322W2 and F444W, utilizing the new DHS mode. Each NIRCam mode will last about 5.5 hours, which includes a transit duration of 1 hour, 1.75 hours for each pre-transit and post-transit baseline and a scheduling window of 1 hour. In total the charged time, including all overheads, is 16.7 hours.

For the NIRCam grism time series with F444W we will use the SUB80S2_4-SPECTRA subarray, in combination with the BRIGHT1 readout mode and 5 groups per integration to achieve flux just below the 80% saturation mark. 5049 integrations with 3.41 s are necessary to cover the full transit. For the F322W2 transit observation in NIRCam grism time series we will utilize the same setup with SUB80S2_4-SPECTRA, BRIGHT1 but with 3 groups per integration to avoid saturation. This results in 6715 integrations of 2.56 s each for the F322W2 observation.

The inclusion of the DHS mode placed our data excess at about 16 GB, exceeding the middle threshold. This is justified by the fact that the

wavelength coverage of DHS is crucial for disentangling clouds and comparing with the existing HST data, without adding additional visit time. Each observation gives the warning "Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure." We acknowledge this fact for our time series observation.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	GJ-436	RA: 11 42 11.0933 (175.5462221d) Dec: +26 42 23.65 (26.70657d) Equinox: J2000	Proper Motion RA: 895.088 mas/yr Proper Motion Dec: -813.550 mas/yr Parallax: 0.1023014" Epoch of Position: 2000	

Comments: Gaia DR3 coordinates at epoch 2000, updated proper motion and parallax.
Category=Star
Description=[Exoplanets, M dwarfs, M stars]
Extended=NO

Observation

Proposal 11144, Observation 1: GJ 436b (F322W2+DHS)

Fri Mar 13 21:02:04 GMT 2026

Diagnostic Status: Warning

Observing Template: NIRCam Grism Time Series

Diagnostics

(GJ 436b (F322W2+DHS) (Obs 1)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Visit 1:1) Warning (Form): Data Excess over middle threshold

(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)	GJ-436	RA: 11 42 11.0933 (175.5462221d) Dec: +26 42 23.65 (26.70657d) Equinox: J2000	Proper Motion RA: 895.088 mas/yr Proper Motion Dec: -813.550 mas/yr Parallax: 0.1023014" Epoch of Position: 2000	

Comments: Gaia DR3 coordinates at epoch 2000, updated proper motion and parallax.
Category=Star
Description=[Exoplanets, M dwarfs, M stars]
Extended=NO

Acquisition

#	Target	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID
1	SAME	SUB32TA_DHS	F405N+F444W	RAPID	9	1	1	0.152	144849

Template

Subarray	No. of Output Channels	SW Channel Mode
SUB82S2_4-SPECTRA	4	GRISM

Spectral Elements

#	Short Pupil+Filter	Long Pupil+Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Integrations	Total Exposure Time	Optional ETC ID
1	GDHS0+F150W2	GRISMR+F322W2	BRIGHT1	3	6715	1	6715	17660.853	227351.7

Special Requirements

Phase 0.9487389089524754 to 0.964498556703722 with period 2.64388312 Days and zero-phase 2454865.084034 HJD
Aperture PA Range 177 to 151 Degrees (V3 176.69233042 to 150.69233042)
Time Series Observation
No Parallel Attachments
On Hold We will update the observation when the new DHSn readout patterns are available

Observation

Proposal 11144, Observation 2: GJ 436b (F444W+DHS)

Fri Mar 13 21:02:04 GMT 2026

Diagnostic Status: Warning

Observing Template: NIRCam Grism Time Series

Diagnostics

(GJ 436b (F444W+DHS) (Obs 2)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Visit 2:1) Warning (Form): Data Excess over middle threshold

(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	GJ-436	RA: 11 42 11.0933 (175.5462221d) Dec: +26 42 23.65 (26.70657d) Equinox: J2000	Proper Motion RA: 895.088 mas/yr Proper Motion Dec: -813.550 mas/yr Parallax: 0.1023014" Epoch of Position: 2000	

Comments: Gaia DR3 coordinates at epoch 2000, updated proper motion and parallax.
Category=Star
Description=[Exoplanets, M dwarfs, M stars]
Extended=NO

Acquisition

#	Target	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID
1	SAME	SUB32TA_DHS	F405N+F444W	RAPID	9	1	1	0.152	144849

Template

Subarray	No. of Output Channels	SW Channel Mode
SUB82S2_4-SPECTRA	4	GRISM

Spectral Elements

#	Short Pupil+Filter	Long Pupil+Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Integrations	Total Exposure Time	Optional ETC ID
1	GDHS0+F150W2	GRISMR+F444W	BRIGHT1	4	5049	1	5049	17671.096	227351.8

Special Requirements

Phase 0.9487389089524754 to 0.964498556703722 with period 2.64388312 Days and zero-phase 2454865.084034 HJD
Aperture PA Range 177 to 331 Degrees (V3 177.17458505 to 331.17458505)
Aperture PA Range 357 to 151 Degrees (V3 357.17458505 to 151.17458505)
Time Series Observation
No Parallel Attachments
On Hold We will update the observation when the new DHSn readout patterns are available