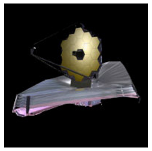

3385 - The first comparative atmospheric study of a Jovian planet and a sub-Neptune in the TOI-1130 system

Cycle: 2, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
TOI-1130 NIRSPEC BOTS				
	1	TOI-1130c	NIRSpec Bright Object Time Series	(1) TOI-1130
	2	TOI-1130b	NIRSpec Bright Object Time Series	(1) TOI-1130
TOI-1130 NIRISS SOSS				
	3	TOI-1130 c	NIRISS Single-Object Slitless Spectroscopy	(1) TOI-1130
	4	TOI 1130 b	NIRISS Single-Object Slitless Spectroscopy	(1) TOI-1130

ABSTRACT

The Solar system has a unique architecture: it hosts planets with drastic mass differences.
Exoplanet systems with similar characteristics hold the key to generalize our understanding in how giant planets influence the formation and evolution of planetary systems.
We request JWST NIRSpec and NIRISS observations to measure the transmission spectra of the TOI-1130 system. TOI-1130 hosts a transiting close-in Jovian planet, and an additional, inner transiting sub-Neptune-sized planet. The two planets are in inclination angle resonances, a strong signature of planetary system formed via disk migration.

We will compare the absolute and relative atmospheric properties of TOI-1130 b and c, including the carbon-to-oxygen ratio, metallicity, and potentially enhancement of other volatile/refractory species. These measurements will enable us to distinguish between various different formation/evolution scenarios of the TOI-1130 system, presents the first opportunity to deep dive into a unique type of system that has never been studied previously.
The outcome of this proposal provide a legacy datapoint in the JWST library of muliplanet systems, as well as a benchmark spectra to compare against other Jovian planets with more ambiguous origins.

OBSERVING DESCRIPTION

We are proposing to conduct a medium programme of ~ 29.7 hr including overheads to observe one transit each for TOI-1130 b and c using NIRSpec in Bright Object Times Series (BOTS) mode and the NIRISS single object slitless spectroscopy (SOSS) mode.

For NIRSpec BOTS, we are using the default S1600A1 slit, and the G395H grating with the F290LP filter and the SUB2048 subarray. This provides resolving power of 1000 with wavelength coverage spanning 2.87-5.10 microns. For each planet, we calculated the visit duration (or dwell time) for JWST observations of transiting exoplanets, given by Tdwell = 0.75 hr (detector settling) + max(1 hr, T14/2) (before transit) +T14 (transit) + max(1 hr, T14/2) (after transit) + 1 hr (timing window), where T14 is the total transit duration. Taken together, this ensures that both the transit and sufficient out-of-transit baseline are acquired, that the detector has sufficient time to settle, and the observation is sufficiently long to provide flexibility with the scheduling window. Respectively for planets b, and c, the transit durations of 2.3, and 2.0 hr result in visit durations of 6.05 and 5.75 hr.

For our observations, we set the number of groups per integration to be the maximum that ensures that none of the pixels in the detector exceeds 60% of its full well capacity. For TOI-1130 (Kmag = 8.351) with the NRSRAPID readout mode and the SUB2048 subarray, this occurred at 8 groups per integration. To cover the calculated visit durations, we used single exposures with 2675 and 2551 integrations for planets b and c, respectively. At the resolution element corresponding to a wavelength of 4.5 microns, this achieves a SNR of 97 per frame, which corresponds to a precision on the transit depth of 410 and 428 ppm. In practice, we will combine the data into wavelength bins to achieve an SNR that is sufficiently high to robustly detect the expected molecular features at these wavelengths.

For NIRISS SOSS, we are using the SUBSTRIP256 (the default for the SOSS observing mode) which covers all spectroscopic orders and provides more pixels with which to estimate the background compared with SUBSTRIP96. We chose the NISRAPID readout pattern. We use similar visit duration calculation as NIRSpec BOTS, which result in visit durations of 6.05 and 5.75 hr for b and c.

For the observations, we use number of 2 groups per integration, which is the minimum value permitted for us to ensure that none of the pixels in the detector exceeds 60% of its full well capactity. We achieve a SNR of ~374 at 1.57 um. For planet TOI-1130 b and c, we will take 1320 and 1259 total integrations, which would give us a transit depth precision of 151 and 158 ppm per transit.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-1130	RA: 19 05 30.2409 (286.3760037d) Dec: -41 26 15.50 (-41.43764d) Equinox: J2000	Proper Motion RA: 0.0011186158816423291 sec of time/yr Proper Motion Dec: -0.027468999951452133 arcsec/yr Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Category=Star Description=[K dwarfs] Extended=NO				
(2)	2MASSJ19053016-4126418	RA: 19 05 30.1678 (286.3756992d) Dec: -41 26 41.83 (-41.44495d) Equinox: J2000	Proper Motion RA: 4.15 mas/yr Proper Motion Dec: -6.94 mas/yr Parallax: 0.70" Epoch of Position: 2018.5	
Comments: This target is used for target aquisition for NIRSpec. The target information is from GaiaDR3 with source id Gaia DR3 6715686975145766528 Category=Star Description=[K dwarfs]				

Observation

Proposal 3385, Observation 1: TOI-1130c

Thu Mar 13 17:00:12 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

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

(Visit 1:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-1130	RA: 19 05 30.2409 (286.3760037d) Dec: -41 26 15.50 (-41.43764d) Equinox: J2000	Proper Motion RA: 0.0011186158816423291 sec of time/yr Proper Motion Dec: -0.027468999951452133 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[K dwarfs]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	2 2MASSJ19053016-4126418	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	138896.2

Template

Subarray
SUB2048

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	NRSRAPID	8	850	3	1	2550	20753.124	138896.1

Special Requirements	
	Between Dates 02-APR-2024:07:42:00 and 02-APR-2024:08:42:00 Between Dates 10-APR-2024:16:05:00 and 10-APR-2024:17:05:00 Between Dates 19-APR-2024:00:29:00 and 19-APR-2024:01:29:00 Between Dates 27-APR-2024:08:55:00 and 27-APR-2024:09:55:00 Between Dates 05-MAY-2024:17:21:00 and 05-MAY-2024:18:21:00 Between Dates 14-MAY-2024:01:48:00 and 14-MAY-2024:02:48:00 Between Dates 22-AUG-2024:06:14:00 and 22-AUG-2024:07:14:00 Between Dates 30-AUG-2024:14:35:00 and 30-AUG-2024:15:35:00 Between Dates 07-SEP-2024:22:58:00 and 07-SEP-2024:23:58:00 Between Dates 16-SEP-2024:07:22:00 and 16-SEP-2024:08:22:00 Between Dates 24-SEP-2024:15:46:00 and 24-SEP-2024:16:46:00 Between Dates 03-OCT-2024:00:07:26 and 03-OCT-2024:01:07:26 Between Dates 04-APR-2025:16:37:18 and 04-APR-2025:17:37:18 Between Dates 13-APR-2025:01:13:47 and 13-APR-2025:02:13:47 Time Series Observation No Parallel Attachments

Observation

Proposal 3385, Observation 2: TOI-1130b

Thu Mar 13 17:00:12 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(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)	TOI-1130	RA: 19 05 30.2409 (286.3760037d) Dec: -41 26 15.50 (-41.43764d) Equinox: J2000	Proper Motion RA: 0.0011186158816423291 sec of time/yr Proper Motion Dec: -0.027468999951452133 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[K dwarfs]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	2 2MASSJ1905301 6-4126418	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	138896.2

Template

Subarray
SUB2048

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	NRSRAPID	8	891	3	1	2673	21754.157	138896.1

Special Requirements	
	Between Dates 30-MAR-2024:17:19:00 and 30-MAR-2024:18:19:00 Between Dates 03-APR-2024:19:16:00 and 03-APR-2024:20:16:00 Between Dates 07-APR-2024:21:23:00 and 07-APR-2024:22:23:00 Between Dates 11-APR-2024:23:14:00 and 12-APR-2024:00:14:00 Between Dates 16-APR-2024:01:10:00 and 16-APR-2024:02:10:00 Between Dates 20-APR-2024:02:54:00 and 20-APR-2024:03:54:00 Between Dates 24-APR-2024:04:39:00 and 24-APR-2024:05:39:00 Between Dates 28-APR-2024:06:17:00 and 28-APR-2024:07:17:00 Between Dates 02-MAY-2024:07:51:00 and 02-MAY-2024:08:51:00 Between Dates 06-MAY-2024:09:24:00 and 06-MAY-2024:10:24:00 Between Dates 10-MAY-2024:10:52:00 and 10-MAY-2024:11:52:00 Between Dates 14-MAY-2024:12:21:00 and 14-MAY-2024:13:21:00 Between Dates 18-MAY-2024:13:47:00 and 18-MAY-2024:14:47:00 Between Dates 20-AUG-2024:10:11:00 and 20-AUG-2024:11:11:00 Between Dates 24-AUG-2024:12:19:00 and 24-AUG-2024:13:19:00 Between Dates 28-AUG-2024:14:38:00 and 28-AUG-2024:15:38:00 Between Dates 01-SEP-2024:16:42:00 and 01-SEP-2024:17:42:00 Between Dates 05-SEP-2024:18:59:00 and 05-SEP-2024:19:59:00 Between Dates 09-SEP-2024:20:58:00 and 09-SEP-2024:21:58:00 Between Dates 13-SEP-2024:23:09:00 and 14-SEP-2024:00:09:00 Between Dates 18-SEP-2024:01:02:00 and 18-SEP-2024:02:02:00 Between Dates 22-SEP-2024:03:07:00 and 22-SEP-2024:04:07:00 Between Dates 26-SEP-2024:04:55:00 and 26-SEP-2024:05:55:00 Time Series Observation No Parallel Attachments

Observation

Proposal 3385, Observation 3: TOI-1130 c

Thu Mar 13 17:00:12 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Comments: PA range 282 to 290 is preferred as priority 1 range given the minimum contamination.
PA ranges 73-75, 83-84, 89.5 to 90, 259 to 261 are preferred as priority 2 ranges.

Diagnostics

(TOI-1130 c (Obs 3)) 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 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-1130	RA: 19 05 30.2409 (286.3760037d) Dec: -41 26 15.50 (-41.43764d) Equinox: J2000	Proper Motion RA: 0.0011186158816423291 sec of time/yr Proper Motion Dec: -0.027468999951452133 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[K dwarfs]
Extended=NO

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 TOI-1130	SOSSFAINT	F480M	NISRAPID	3	1	1	0.202	138896.4

Template

Subarray	Include Short First Exposure and F277W Exposure?
SUBSTRIP256	false

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	2	1259	1	1259	20776.622	138896.3

Special Requirements	Between Dates 02-APR-2024:07:42:00 and 02-APR-2024:08:42:00 Between Dates 10-APR-2024:16:05:00 and 10-APR-2024:17:05:00 Between Dates 19-APR-2024:00:29:00 and 19-APR-2024:01:29:00 Between Dates 27-APR-2024:08:55:00 and 27-APR-2024:09:55:00 Between Dates 05-MAY-2024:17:21:00 and 05-MAY-2024:18:21:00 Between Dates 14-MAY-2024:01:48:00 and 14-MAY-2024:02:48:00 Between Dates 22-AUG-2024:06:14:00 and 22-AUG-2024:07:14:00 Between Dates 30-AUG-2024:14:35:00 and 30-AUG-2024:15:35:00 Between Dates 07-SEP-2024:22:58:00 and 07-SEP-2024:23:58:00 Between Dates 16-SEP-2024:07:22:00 and 16-SEP-2024:08:22:00 Between Dates 24-SEP-2024:15:46:00 and 24-SEP-2024:16:46:00 Aperture PA Range 72 to 85 Degrees (V3 71.43873283 to 84.43873283) Aperture PA Range 88.5 to 90 Degrees (V3 87.93873283 to 89.43873283) Aperture PA Range 258 to 268 Degrees (V3 257.43873283 to 267.43873283) Aperture PA Range 282 to 290 Degrees (V3 281.43873283 to 289.43873283) Time Series Observation No Parallel Attachments

Observation

Proposal 3385, Observation 4: TOI 1130 b

Thu Mar 13 17:00:12 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Comments: PA range 282 to 290 is preferred as priority 1 range given the minimum contamination.
PA ranges 73-75, 83-84, 89.5 to 90, 259 to 261 are preferred as priority 2 ranges.

Diagnostics

(TOI 1130 b (Obs 4)) 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 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-1130	RA: 19 05 30.2409 (286.3760037d) Dec: -41 26 15.50 (-41.43764d) Equinox: J2000	Proper Motion RA: 0.0011186158816423291 sec of time/yr Proper Motion Dec: -0.027468999951452133 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[K dwarfs]
Extended=NO

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 TOI-1130	SOSSFAINT	F480M	NISRAPID	3	1	1	0.202	138896.4

Template

Subarray	Include Short First Exposure and F277W Exposure?
SUBSTRIP256	false

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	2	1320	1	1320	21783.274	138896.3

Special Requirements	Between Dates 30-MAR-2024:17:19:00 and 30-MAR-2024:18:19:00 Between Dates 03-APR-2024:19:16:00 and 03-APR-2024:20:16:00 Between Dates 07-APR-2024:21:23:00 and 07-APR-2024:22:23:00 Between Dates 11-APR-2024:23:14:00 and 12-APR-2024:00:14:00 Between Dates 16-APR-2024:01:10:00 and 16-APR-2024:02:10:00 Between Dates 20-APR-2024:02:54:00 and 20-APR-2024:03:54:00 Between Dates 24-APR-2024:04:39:00 and 24-APR-2024:05:39:00 Between Dates 28-APR-2024:06:17:00 and 28-APR-2024:07:17:00 Between Dates 02-MAY-2024:07:51:00 and 02-MAY-2024:08:51:00 Between Dates 06-MAY-2024:09:24:00 and 06-MAY-2024:10:24:00 Between Dates 10-MAY-2024:10:52:00 and 10-MAY-2024:11:52:00 Between Dates 14-MAY-2024:12:21:00 and 14-MAY-2024:13:21:00 Between Dates 18-MAY-2024:13:47:00 and 18-MAY-2024:14:47:00 Between Dates 20-AUG-2024:10:11:00 and 20-AUG-2024:11:11:00 Between Dates 24-AUG-2024:12:18:00 and 24-AUG-2024:13:18:00 Between Dates 28-AUG-2024:14:38:00 and 28-AUG-2024:15:38:00 Between Dates 01-SEP-2024:16:42:00 and 01-SEP-2024:17:42:00 Between Dates 05-SEP-2024:18:59:00 and 05-SEP-2024:19:59:00 Between Dates 09-SEP-2024:20:58:00 and 09-SEP-2024:21:58:00 Between Dates 13-SEP-2024:23:09:00 and 14-SEP-2024:00:09:00 Between Dates 18-SEP-2024:01:02:00 and 18-SEP-2024:02:02:00 Between Dates 22-SEP-2024:03:07:00 and 22-SEP-2024:04:07:00 Between Dates 26-SEP-2024:04:55:00 and 26-SEP-2024:05:55:00 Aperture PA Range 72 to 85 Degrees (V3 71.43873283 to 84.43873283) Aperture PA Range 88.5 to 90 Degrees (V3 87.93873283 to 89.43873283) Aperture PA Range 258 to 268 Degrees (V3 257.43873283 to 267.43873283) Aperture PA Range 282 to 290 Degrees (V3 281.43873283 to 289.43873283) Time Series Observation No Parallel Attachments