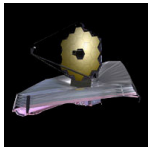

1224 - Transiting exoplanet characterization with JWST/NIRSPEC

Cycle: 1, Proposal Category: GTO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	L98-59d - Transit	NIRSpec Bright Object Time Series	(9) L98-59
	2	WASP-43b - Phase curve	NIRSpec Bright Object Time Series	(2) WASP-43
	3	WASP-107b - Transit	NIRSpec Bright Object Time Series	(3) WASP-107
	4	WASP-52b - Eclipse	NIRSpec Bright Object Time Series	(4) WASP-52

ABSTRACT

JWST will revolutionize the study of exoplanet atmospheres by virtue of broader wavelength coverage, higher spectral resolution, better sensitivity, and longer uninterrupted observing time than existing facilities. Observable characteristics of exoplanets from primary and secondary eclipses, as well as phase curve observations, include: atmospheric composition probed by the presence and relative strength of spectral lines from different species; vertical thermal structure diagnosed by the relative strength of spectral lines of the same species formed at different pressures/heights in the atmosphere; formation of clouds and/or hazes revealed by the strength of line features relative to the continuum; and transverse heat redistribution and winds probed by the relative brightness at different orbital phases. We will use JWST/NIRSpec to execute three programs looking at different categories of planets and performing different types of investigations:

- attempting to detect molecular features in a super-Earth by taking spectra over the 2.9-5.2 micron wavelength range;
- obtaining a full phase curve of a hot Jupiter with high spectral resolution in the 2.9-5.2 micron wavelength range;
- taking a first NIRSpec look at the diversity of giant planets through a comparative study of two planets

The observations in this proposal correspond to observation IDs FERRUIT_5000, FERRUIT_5001, FERRUIT_5002, and FERRUIT_5003. Charged time (APT 2020.2): 48.91 hours

OBSERVING DESCRIPTION

We will acquire a high-resolution transit spectra of the super-Earth L 98-59b and the warm super-Neptune/sub-Saturn WASP-107, a low resolution / full wavelength coverage eclipse spectra of WASP-52b, and the full phase curve of WASP-43b. The R = / ~ 2700 transit spectra will be taken using NIRSpec's 1.6 × 1.6 arcsec fixed slit and the corresponding gratings. The R ~ 100 eclipse spectra of WASP-52b will be obtained using the low resolution prism. We will make use of the NIRSpec Bright Object Time Series (BOTS) template, where long, non-dithered exposures are available with JWST staring at one pointing for the full duration of the visit.

Building on HST experience, each transit (duration t) should be bracketed by sufficient baseline integration in the same mode as the science observation to allow modeling of instrumental artifacts through the transit. The purpose of the baseline (duration b1 before and b2 after) is to enable subtracting or dividing by slow instrumental drifts. For Cycle 1, we have included sufficient baseline using the following scheme:

• For transits with a duration t less than 55 minutes, we take the full transit duration before and after, b1 = b2 = t.
• For transits longer than 55 minutes, but shorter than 2 hours, we acquire 55 minutes of baseline before and after the transit, b1 = b2 = 55 minutes.
• for transits longer than 2 hours, we acquire half the transit time before and after, b1 = b2 = t/2.

This scheme will ensure that we always have at least one full transit time outside the transit event. Pending analysis of Cycle 1 data, we may revisit this for Cycle 2 with the aim of reducing the baseline integration times.

APT also requires us to provide an earliest and latest start phase for these time critical visits. Currently, a "direct scheduling" overhead of 1 hour is charged for programs with tight time window (TTW) constraints. As of 20 November 2017, TTW are observations with a timing contraint of less than 1 hour. Therefore, we have designed the observations using a 60 minute window so that no direct scheduling overhead occurs (t/2) before center of transit/eclipse the latest, and one hour earlier than that at the earliest. Therefore, the total baseline data collected will be 2 times b1 + 60 minutes

long, with typically (on average) half of it before and half of it after the transit.

NIRSpec testing during CV3 and OTIS showed that the ASICs require only a short amount (15 minutes) of setting time after changing into subarray mode, if any. Therefore, we will have an adequate amount of baseline before and after the event with the above described schema in all cases.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	WASP-43	RA: 10 19 37.9634 (154.9081808d) Dec: -09 48 23.21 (-9.80645d) Equinox: J2000	Proper Motion RA: -41.992 mas/yr Proper Motion Dec: -38.004 mas/yr Parallax: 0.0114740" Epoch of Position: 2016.0	

Comments: Positions and proper motions from GAIA DR3 (epoch 2016.0) source ID 3767805209112436736
B 13.4 [~] E 2001AJ....121.1752M
V 12.4 [~] D 2011A&A...535L...7H
R 12.08 [0.08] E 2009yCat.1315....0Z
I 11.10 [0.02] C 2005yCat.2263....0T
G 11.9070 [0.0018] C 2018yCat.1345....0G
J 9.995 [0.024] C 2003yCat.2246....0C
H 9.397 [0.025] C 2003yCat.2246....0C
K 9.267 [0.026] C 2003yCat.2246....0C
Category=Star
Description=[Exoplanet Systems]
Extended=NO

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	WASP-107	RA: 12 33 32.7394 (188.3864142d) Dec: -10 08 46.38 (-10.14622d) Equinox: J2000	Proper Motion RA: -96.665 mas/yr Proper Motion Dec: -9.372 mas/yr Parallax: 0.0155277" Epoch of Position: 2016.0	

Comments: Positions and proper motions from GAIA DR3 (epoch 2016.0, ID 3578638842054261248).
K6 D 2017A&A...604A.110A
Fluxes (6) :
B 14.62 [1.20] D 2000A&A...355L..27H
V 11.47 [0.20] D 2000A&A...355L..27H
G 11.1740 [0.0009] C 2018yCat.1345....0G
J 9.378 [0.021] C 2003yCat.2246....0C
H 8.777 [0.026] C 2003yCat.2246....0C
K 8.637 [0.023] C 2003yCat.2246....0C
Category=Star
Description=[Exoplanet Systems]
Extended=NO

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(4)	WASP-52	RA: 23 13 58.7501 (348.4947921d) Dec: +08 45 39.86 (8.76107d) Equinox: J2000	Proper Motion RA: -6.942 mas/yr Proper Motion Dec: -44.330 mas/yr Parallax: 0.0057262" Epoch of Position: 2016.0	

Comments: Positions and proper motion from GAIA DR3 (epoch 2016.0 ID 2666015878575546496).
K2V C 2013A&A...549A.134H
Fluxes (7) :
B 12.9 [~] D 2013A&A...549A.134H
V 12.0 [~] D 2013A&A...549A.134H
R 12.03 [0.06] E 2012yCat.1322....0Z
G 11.9537 [0.0011] C 2018yCat.1345....0G
J 10.588 [0.022] C 2003yCat.2246....0C
H 10.186 [0.028] C 2003yCat.2246....0C
K 10.086 [0.025] C 2003yCat.2246....0C
Category=Star
Description=[Exoplanet Systems]
Extended=NO

(6)	WASP-43-TA-REF	RA: 10 19 36.3625 (154.9015104d)	Proper Motion RA: -16.137 mas/yr
		Dec: -09 48 42.50 (-9.81181d)	Proper Motion Dec: -65.398 mas/yr
		Equinox: J2000	Parallax: 0.0017764"
			Epoch of Position: 2016.0

Comments: close to WASP-43 (0.52 arcmin, PA 231, source ID 3767805209112907392) taken from GAIA DR3
Gmag: 17.010
Jmag: 15.125
Hmag: 14.570
Kmag: 14.313
(2MASS)
Category=Unidentified
Description=[Infrared sources, Visible sources]
Extended=NO

(7)	WASP-107-TA-REF	RA: 12 33 35.6813 (188.3986721d)	Proper Motion RA: 1.351 mas/yr
		Dec: -10 08 45.22 (-10.14589d)	Proper Motion Dec: -8.927 mas/yr
		Equinox: J2000	Parallax: 0.0004418"
			Epoch of Position: 2016.0

Comments: from GAIA DR3 (ID 3578638803399179136)
Gmag: 18.235
J: 16.456
H: 15.612
K: 14.817
Category=Unidentified
Description=[Infrared sources, Visible sources]
Extended=NO

(8)	WASP-52-TA-REF	RA: 23 14 0.2627 (348.5010946d)	Proper Motion RA: 2.598 mas/yr
		Dec: +08 45 34.45 (8.75957d)	Proper Motion Dec: -3.714 mas/yr
		Equinox: J2000	Parallax: 0.0006166"
			Epoch of Position: 2016.0

Comments: close to WASP-52 (0.39 arcmin, PA 105, source ID 2666015874279964672), taken from GAIA DR3
Gmag: 19.903
Category=Unidentified
Description=[Infrared sources, Visible sources]
Extended=NO

(9)	L98-59	RA: 08 18 7.8951 (124.5328963d)	Proper Motion RA: 94.794 mas/yr
		Dec: -68 18 52.25 (-68.31451d)	Proper Motion Dec: -340.084 mas/yr
		Equinox: J2000	Parallax: 0.0942664"
			Epoch of Position: 2016.0

Comments: coordinates, proper motions and parallax from GAIA DR3 (Epoch 2016.0 ID 5271055243163629056)
J 7.933 [0.027] C 2003yCat.2246....0C
H 7.359 [0.049] C 2003yCat.2246....0C
K 7.101 [0.018] C 2003yCat.2246....0C
Category=Star
Description=[Exoplanet Systems, M dwarfs]
Extended=NO

(10)	L98-59-TA-REF	RA: 08 18 10.5211 (124.5438379d)	Proper Motion RA: -1.552 mas/yr
		Dec: -68 18 55.88 (-68.31552d)	Proper Motion Dec: 5.736 mas/yr
		Equinox: J2000	Parallax: 0.0002783"
			Epoch of Position: 2016.0

Comments: TA reference star from GAIA DR3, ID 5271055170147005696
GMag 20.384
BPmag 20.836
RPmag 19.410
Category=Unidentified
Description=[Infrared sources, Visible sources]

Observation

Proposal 1224, Observation 1: L98-59d - Transit Fri Sep 09 20:01:10 GMT 2022

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Comments: Period, Duration, and Mid-Point from Kostov et al. 2019

Diagnostics

(L98-59d - Transit (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): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(9)	L98-59	RA: 08 18 7.8951 (124.5328963d)	Proper Motion RA: 94.794 mas/yr	
		Dec: -68 18 52.25 (-68.31451d)	Proper Motion Dec: -340.084 mas/yr	
		Equinox: J2000	Parallax: 0.0942664"	
			Epoch of Position: 2016.0	

Comments: coordinates, proper motions and parallax from GAIA DR3 (Epoch 2016.0 ID 5271055243163629056)
J 7.933 [0.027] C 2003yCat.2246....0C
H 7.359 [0.049] C 2003yCat.2246....0C
K 7.101 [0.018] C 2003yCat.2246....0C
Category=Star
Description=[Exoplanet Systems, M 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	10 L98-59-TA-REF	WATA	SUB2048	F140X	NRSRAPID	3	1	1	3.628	109288.59

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	6	2121	1	1	2121	13435.432	25225

Special Requirements	
	Phase 0.986774457 to 0.992366653 with period 7.45086 Days and zero-phase 2458362.7375 HJD Time Series Observation No Parallel

Observation

Proposal 1224, Observation 2: WASP-43b - Phase curve Fri Sep 09 20:01:10 GMT 2022

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Comments: Period from Hoyer et al. 2016
Duration from Hellier et al. 2011
Mid-Point from Bonomo et al. 2017

We doubled the actual period of 0.813473978 days in order to ensure that the observation is phase contrained like the others, so that 2 eclipses and one transit will be observed over the phase curve. The phase range was adjusted accordingly.

Diagnostics

(WASP-43b - Phase curve (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): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	WASP-43	RA: 10 19 37.9634 (154.9081808d)	Proper Motion RA: -41.992 mas/yr	
		Dec: -09 48 23.21 (-9.80645d)	Proper Motion Dec: -38.004 mas/yr	
		Equinox: J2000	Parallax: 0.0114740"	
			Epoch of Position: 2016.0	

Comments: Positions and proper motions from GAIA DR3 (epoch 2016.0) source ID 3767805209112436736
B 13.4 [~] E 2001AJ....121.1752M
V 12.4 [~] D 2011A&A...535L...7H
R 12.08 [0.08] E 2009yCat.1315....0Z
I 11.10 [0.02] C 2005yCat.2263....0T
G 11.9070 [0.0018] C 2018yCat.1345....0G
J 9.995 [0.024] C 2003yCat.2246....0C
H 9.397 [0.025] C 2003yCat.2246....0C
K 9.267 [0.026] C 2003yCat.2246....0C
Category=Star
Description=[Exoplanet Systems]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	6 WASP-43-TA-REF	WATA	SUB32	F140X	NRSRAPIDD6	3	1	1	0.26	25225

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	20	4498	1	1	4498	85293.235	25225

Special Requirements	
	Phase 0.183935604 to 0.209545930 with period 1.626947956 Days and zero-phase 2455934.792 HJD Time Series Observation No Parallel

Observation

Proposal 1224, Observation 3: WASP-107b - Transit Fri Sep 09 20:01:10 GMT 2022

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Comments: Zero phase, period and t14 duration from T. Monik, C. Hellier, D. R. Anderson, B. J. M. Clark, J. Southworth (2017)
https://arxiv.org/abs/1702.05078v2
Will revisit target acquisition reference target once GAIA DR2 is released.

Diagnostics

(WASP-107b - Transit (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.

(WASP-107b - Transit (Obs 3)) Warning (Form): The slew between the acquisition exposure and the farthest science exposure is 44.157 Arcsec (larger than the recommended limit of 40.000 Arcsec) and may result in reduced or no schedulability. See more information in the diagnostic browser.

(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	WASP-107	RA: 12 33 32.7394 (188.3864142d)	Proper Motion RA: -96.665 mas/yr	
		Dec: -10 08 46.38 (-10.14622d)	Proper Motion Dec: -9.372 mas/yr	
		Equinox: J2000	Parallax: 0.0155277"	
			Epoch of Position: 2016.0	

Comments: Positions and proper motions from GAIA DR3 (epoch 2016.0, ID 3578638842054261248).
K6 D 2017A&A...604A.110A
Fluxes (6) :
B 14.62 [1.20] D 2000A&A...355L..27H
V 11.47 [0.20] D 2000A&A...355L..27H
G 11.1740 [0.0009] C 2018yCat.1345....0G
J 9.378 [0.021] C 2003yCat.2246....0C
H 8.777 [0.026] C 2003yCat.2246....0C
K 8.637 [0.023] C 2003yCat.2246....0C
Category=Star
Description=[Exoplanet Systems]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	7 WASP-107-TA-REF	WATA	SUB32	F140X	NRSRAPIDD6	3	1	1	0.26	25225

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	20	1230	1	1	1230	23323.85	25225

Special Requirements	
	Phase 0.969132180 to 0.976414662 with period 5.72149242 Days and zero-phase 2457584.329746 HJD Time Series Observation No Parallel

Observation

Proposal 1224, Observation 4: WASP-52b - Eclipse Fri Sep 09 20:01:10 GMT 2022

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Comments: Bright, but still OK for direct TA with one saturated pixel (or less).
Period from Özturk & Erdem 2019
Duration from Hebrard et al. 2013
Mid-Point from Bonomo et al. 2017

Diagnostics

(WASP-52b - Eclipse (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
(4)	WASP-52	RA: 23 13 58.7501 (348.4947921d)	Proper Motion RA: -6.942 mas/yr	
		Dec: +08 45 39.86 (8.76107d)	Proper Motion Dec: -44.330 mas/yr	
		Equinox: J2000	Parallax: 0.0057262"	
			Epoch of Position: 2016.0	

Comments: Positions and proper motion from GAIA DR3 (epoch 2016.0 ID 2666015878575546496).
K2V C 2013A&A...549A.134H
Fluxes (7) :
B 12.9 [~] D 2013A&A...549A.134H
V 12.0 [~] D 2013A&A...549A.134H
R 12.03 [0.06] E 2012yCat.1322....0Z
G 11.9537 [0.0011] C 2018yCat.1345....0G
J 10.588 [0.022] C 2003yCat.2246....0C
H 10.186 [0.028] C 2003yCat.2246....0C
K 10.086 [0.025] C 2003yCat.2246....0C
Category=Star
Description=[Exoplanet Systems]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	25225

Template

Subarray
SUB512S

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	PRISM/CLEAR	NRSRAPID	3	29096	1	1	29096	17345.871	25225

Special Requirements	
	Phase 0.430829510 to 0.454641989 with period 1.7497828 Days and zero-phase 2456673.821 HJD Time Series Observation No Parallel