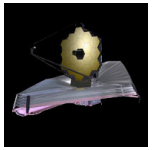

2062 - Transmission Spectroscopy of the Super-Neptune WASP-166b

Cycle: 1, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
Andrew Mayo (PI)	**University of California - Berkeley**
Dr. Courtney Dressing (CoI) (CoPI)	University of California - Berkeley
Dr. Steven Giacalone (CoI)	California Institute of Technology
Emma Turtelboom (CoI)	University of California - Berkeley
Caleb Harada (CoI)	University of California - Berkeley
Charles Fortenbach (CoI)	San Francisco State University

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
WASP-166b NIRISS SOSS				
	1	WASP-166b NIRISS SOSS	NIRISS Single-Object Slitless Spectroscopy	(1) WASP-166
	4	WASP-166b NIRISS SOSS - Repeat of observation 1	NIRISS Single-Object Slitless Spectroscopy	(1) WASP-166
WASP-166b NIRSpec BOTS				
	2	WASP-166b NIRSpec BOTS	NIRSpec Bright Object Time Series	(1) WASP-166
	3	WASP-166b NIRSpec BOTS	NIRSpec Bright Object Time Series	(1) WASP-166

ABSTRACT

We propose a Small GO program (22.83 hrs Charged Time) to analyze the atmosphere of WASP-166b, a hot, puffy, super-Neptune exoplanet (P = 5.44354 d, Mp = 32.1 ± 1.6 M_earth, Rp = 7.1 ± 0.3 R_earth, Teq = 1270 ± 30 K). We will conduct transmission spectroscopy of one transit of

WASP-166b with NIRISS SOSS Order-1 (0.9 to 2.8 microns) and a second transit with NIRSpec BOTS G395M/F290LP (2.87 to 5.18 microns). These observations will allow us to constrain or place upper limits on the abundances of H2O, CO, CH4, CO2, C2H2, HCN, and NH3. WASP-166b is in a sparsely populated region of mass-insolation flux space known as the “hot Neptune desert”, therefore the planet’s formation history will help us probe the origin and nature of the desert. Our proposed transmission spectroscopy of WASP-166b will yield meaningful constraints on molecular abundances, metallicity, and C/O ratio, thereby providing insight into the composition, formation pathway, and evolution of planets of this class. Comparing our abundance results to theoretical models and observations of other planets will help assess theories for the origin and nature of the hot Neptune desert.

OBSERVING DESCRIPTION

We will collect transmission spectroscopy observations of the hot super-Neptune WASP-166b. We will observe one transit with NIRISS SOSS Order 1 (0.9 to 2.8 microns) and a second transit with NIRSpec BOTS G395M/F290LP (2.87 to 5.18 microns). For the NIRISS SOSS observation we can use the primary source for target acquisition (TA). For the NIRSpec observation the primary source is too bright to be used for TA. In this case, we have identified an appropriate TA source (2MASS-J09393250-2058249) within the Visit Splitting Distance.

Both of the observations are Time Series Observations, with No Parallels involved. We have used the standard JWST transit observation Dwell Time calculation to determine our Exposure Times (~ 8.95 hrs for each observation). Starting Phase constraints have been determined (using the ExoCTK tools) based on up-to-date values for the planet’s orbital period (5.44354 days) and transit duration (~ 3.6 hrs). For the NIRISS SOSS observation we have provided Aperture Phase Angle constraints to avoid spectral contamination from nearby stars (again, using the ExoCTK tools). We have also included an F277W exposure to enable the isolation of the 1st-order spectrum in the order overlap region. The total Charged Time for our proposed observations is 22.83 hours.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	WASP-166	RA: 09 39 30.0251 (144.8751046d) Dec: -20 58 56.71 (-20.98242d) Equinox: J2000	Proper Motion RA: -0.003932924174077083 sec of time/yr Proper Motion Dec: 0.010927 arcsec/yr Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Exoplanets, F stars]* *Extended=NO*				
(2)	2MASS-J09393250-2058249	RA: 09 39 32.5200 (144.8855000d) Dec: -20 58 25.31 (-20.97370d) Equinox: J2000	Proper Motion RA: 7.12304 mas/yr Proper Motion Dec: -11.0717 mas/yr Epoch of Position: 2015.5	
Comments: This object is also known as TIC 408309997. The ref catalog for the 2015.5 epoch and proper motion data is Gaia DR2 (source ID is 5664957547259311360). *Category=Star* *Description=[K stars]* *Extended=NO*				

Observation

Proposal 2062, Observation 1: WASP-166b NIRISS SOSS

Wed Dec 13 21:42:28 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Diagnostics

(WASP-166b NIRISS SOSS (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.

(Exposure) 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
(1)	WASP-166	RA: 09 39 30.0251 (144.8751046d) Dec: -20 58 56.71 (-20.98242d) Equinox: J2000	Proper Motion RA: -0.003932924174077083 sec of time/yr Proper Motion Dec: 0.010927 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanets, F stars]
Extended=NO

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	SOSSFAINT	F480M	NISRAPID	3	1	1	0.202	122045

Template

Subarray	Include Short First Exposure and F277W Exposure?
SUBSTRIP96	true

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	2	4836	1	4836	32219.753	122045
2	NISRAPID	2	20	1	20	133.25	122045

Special Requirements

Phase 0.95904931962 to 0.966704 with period 5.44354 Days and zero-phase 2457664.3289 HJD
Aperture PA Range 65 to 77 Degrees (V3 64.43873283 to 76.43873283)
Aperture PA Range 106 to 117 Degrees (V3 105.43873283 to 116.43873283)
Aperture PA Range 288 to 292 Degrees (V3 287.43873283 to 291.43873283)
Aperture PA Range 296 to 299 Degrees (V3 295.43873283 to 298.43873283)
Aperture PA Range 303 to 311 Degrees (V3 302.43873283 to 310.43873283)
Aperture PA Range 320 to 321 Degrees (V3 319.43873283 to 320.43873283)
Time Series Observation
No Parallel Attachments

Observation

Proposal 2062, Observation 4: WASP-166b NIRISS SOSS - Repeat of observation 1

Wed Dec 13 21:42:28 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Diagnostics

(WASP-166b NIRISS SOSS - Repeat of observation 1 (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.

(Exposure) 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)	WASP-166	RA: 09 39 30.0251 (144.8751046d) Dec: -20 58 56.71 (-20.98242d) Equinox: J2000	Proper Motion RA: -0.003932924174077083 sec of time/yr Proper Motion Dec: 0.010927 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanets, F stars]
Extended=NO

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	SOSSFAINT	F480M	NISRAPID	3	1	1	0.202	122045

Template

Subarray	Include Short First Exposure and F277W Exposure?
SUBSTRIP96	true

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	2	4836	1	4836	32219.753	122045
2	NISRAPID	2	20	1	20	133.25	122045

Special Requirements

Phase 0.95904931962 to 0.966704 with period 5.44354 Days and zero-phase 2457664.3289 HJD
Aperture PA Range 65 to 77 Degrees (V3 64.43873283 to 76.43873283)
Aperture PA Range 106 to 117 Degrees (V3 105.43873283 to 116.43873283)
Aperture PA Range 288 to 292 Degrees (V3 287.43873283 to 291.43873283)
Aperture PA Range 296 to 299 Degrees (V3 295.43873283 to 298.43873283)
Aperture PA Range 303 to 311 Degrees (V3 302.43873283 to 310.43873283)
Aperture PA Range 320 to 321 Degrees (V3 319.43873283 to 320.43873283)
Time Series Observation
No Parallel Attachments

Observation

Proposal 2062, Observation 2: WASP-166b NIRSpec BOTS

Wed Dec 13 21:42:28 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(WASP-166b NIRSpec BOTS (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
(1)	WASP-166	RA: 09 39 30.0251 (144.8751046d) Dec: -20 58 56.71 (-20.98242d) Equinox: J2000	Proper Motion RA: -0.003932924174077083 sec of time/yr Proper Motion Dec: 0.010927 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanets, F stars]
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 2MASS-J09393250-2058249	WATA	SUB32	CLEAR	NRSRAPID	3	1	1	0.08	122045

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	G395M/F290LP	NRSRAPID	3	8880	1	1	8880	32220.902	122045

Special Requirements

Phase 0.95904931962 to 0.966704 with period 5.443540 Days and zero-phase 2457664.3289 HJD
Time Series Observation
No Parallel Attachments

Observation

Proposal 2062, Observation 3: WASP-166b NIRSpec BOTS

Wed Dec 13 21:42:28 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(WASP-166b NIRSpec BOTS (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)	WASP-166	RA: 09 39 30.0251 (144.8751046d) Dec: -20 58 56.71 (-20.98242d) Equinox: J2000	Proper Motion RA: -0.003932924174077083 sec of time/yr Proper Motion Dec: 0.010927 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanets, F stars]
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 2MASS-J09393250-2058249	WATA	SUB32	CLEAR	NRSRAPID	3	1	1	0.08	122045

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	G395M/F290LP	NRSRAPID	3	8880	1	1	8880	32220.902	122045

Special Requirements

Phase 0.95904931962 to 0.966704 with period 5.443540 Days and zero-phase 2457664.3289 HJD
Time Series Observation
No Parallel Attachments