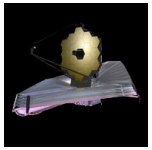

2722 - Chemical Disequilibrium in a Temperate sub-Neptune

Cycle: 1, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
K2-18b				
	1	G395H	NIRSpec Bright Object Time Series	(1) K2-18
	2	MIRI	MIRI Low Resolution Spectroscopy	(1) K2-18
	4	MIRI	MIRI Low Resolution Spectroscopy	(1) K2-18
	3	NIRISS	NIRISS Single-Object Slitless Spectroscopy	(1) K2-18

ABSTRACT

One of the major developments in the past year has been the first detection of H2O in the atmosphere of the mini-Neptune K2-18b orbiting in the habitable-zone of its host star, with an equilibrium temperature of ~300 K. The observations revealed an H2-rich atmosphere with strong absorption from H2O, but also a surprising paucity of methane (CH4) and ammonia (NH3). Given the low temperatures in the atmosphere, CH4 and NH3 are expected to be the prominent carriers of carbon and nitrogen in a H2-rich atmosphere. The non-detections of CH4 and NH3, therefore, suggest strong thermochemical disequilibrium in the atmosphere of K2-18b, similar to the "missing methane problem" in other low-mass planets which is one of the longest-standing conundrums in exoplanetary atmospheres. Given its low temperature and high observability, K2-18b serves as the perfect test case for investigating this problem and for understanding physical and chemical processes in exoplanetary atmospheres in the temperate regime. We

propose to conduct unprecedented observations of K2-18b to resolve this long-standing puzzle. Using JWST broadband transmission spectroscopy with NIRISS, NIRSpec and MIRI, our observations aim to make the first detections of CH4 and NH3 in K2-18b and place unprecedented constraints on chemical disequilibrium in its atmosphere.

OBSERVING DESCRIPTION

We will observe the temperate sub-Neptune K2-18b in transmission with NIRISS, NIRSpec and MIRI, dedicating one primary transit to each instrument.

We will obtain a combined transmission spectrum spanning a wavelength range of 1-8μm.

We will use NIRISS in SOSS mode with the GR700XD grism and the SUBSTRIP96 subarray, obtaining the first spectral order.

With NIRSpec in BOTS mode we will use the G395H grating and the SUB2048 subarray.

MIRI's Low Resolution Spectrometer will be used in Slitless mode.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	K2-18	RA: 11 30 14.4311 (172.5601296d) Dec: +07 35 16.13 (7.58781d) Equinox: J2000	Proper Motion RA: -80.47898512176958 mas/yr Proper Motion Dec: -133.00683042964056 mas/yr Parallax: 0.026246877164178752" Epoch of Position: 2016	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[M dwarfs]* *Extended=NO*				
(2)	2MASSJ11301306+0735116	RA: 11 30 13.0170 (172.5542375d) Dec: +07 35 11.59 (7.58655d) Equinox: J2000	Proper Motion RA: -48.68017233601054 mas/yr Proper Motion Dec: -13.319284639576672 mas/yr Parallax: 0.005626807196112433" Epoch of Position: 2016	
Comments: This object was generated by the targetselector and retrieved from the 2MASS database. *This object is to be used only for target acquisition for the NIRSpec observations, as it is within splitting distance of our main target K2-18.* *The object is known to be a point source in the 2MASS catalogue with a J mag of 15.7. However, it's spectral type is unknown. Therefore, we have categorised it as an unidentified infrared source.* *Category=Unidentified* *Description=[Infrared sources]* *Extended=NO*				

Observation

Proposal 2722, Observation 1: G395H

Thu Apr 11 21:00:26 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(G395H (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
(1)	K2-18	RA: 11 30 14.4311 (172.5601296d) Dec: +07 35 16.13 (7.58781d) Equinox: J2000	Proper Motion RA: -80.47898512176958 mas/yr Proper Motion Dec: -133.00683042964056 mas/yr Parallax: 0.026246877164178752" Epoch of Position: 2016	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[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	2 2MASSJ11301306+0735116	WATA	SUB32	F140X	NRSRAPIDD6	3	1	1	0.26	74909

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	12	1625	1	1	1625	19088.03	62532

Special Requirements

Phase 0.9955727645990364 to 0.9968376889993117 with period 32.940045 Days and zero-phase 2457725.551189 HJD
Time Series Observation
No Parallel Attachments

Observation

Proposal 2722, Observation 2: MIRI Thu Apr 11 21:00:26 GMT 2024

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Diagnostics

(MIRI (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.

(MIRI (Obs 2)) Warning (Form): Groups/Int cannot be 1, Groups/Int = 2 requires permission and Groups/Int of 3-4 is allowed but not recommended.

(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)	K2-18	RA: 11 30 14.4311 (172.5601296d) Dec: +07 35 16.13 (7.58781d) Equinox: J2000	Proper Motion RA: -80.47898512176958 mas/yr Proper Motion Dec: -133.00683042964056 mas/yr Parallax: 0.026246877164178752" Epoch of Position: 2016	

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

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	F560W	FAST	4	1	1	0.636	62532

Template

Subarray	Obtain Verification Image?
SLITLESSPRISM	true

Dithers

#	Dither Type	No. Spectral Steps	Spectral Step Offset	No. Spatial Steps	Spatial Step Offset
1	NONE				

Pointing Verification

#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter
1	FASTR1	4	1	1	1	1	0.636		F560W

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	FASTR1	25	5095	5095	1	1	21067.87	85387

Special Requirements

Phase 0.9949403023988987 to 0.9962052267991741 with period 32.940045 Days and zero-phase 2457725.551189 HJD
Time Series Observation
No Parallel Attachments
No Parallel Attachments

Sequence Observations 2, 4, Non-interruptible

Observation

Proposal 2722, Observation 4: MIRI

Thu Apr 11 21:00:26 GMT 2024

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Diagnostics

(MIRI (Obs 4)) Warning (Form): Groups/Int cannot be 1, Groups/Int = 2 requires permission and Groups/Int of 3-4 is allowed but not recommended.

(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)	K2-18	RA: 11 30 14.4311 (172.5601296d) Dec: +07 35 16.13 (7.58781d) Equinox: J2000	Proper Motion RA: -80.47898512176958 mas/yr Proper Motion Dec: -133.00683042964056 mas/yr Parallax: 0.026246877164178752" Epoch of Position: 2016	

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

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 K2-18	F560W	FAST	4	1	1	0.636	62532

Template

Subarray	Obtain Verification Image?
SLITLESSPRISM	true

Dithers

#	Dither Type	No. Spectral Steps	Spectral Step Offset	No. Spatial Steps	Spatial Step Offset
1	NONE				

Pointing Verification

#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter
1	FASTR1	4	1	1	1	1	0.636		F560W

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	FASTR1	25	30	30	1	1	123.892	85387

Special Requirements

Offset 20.0 arcsec, 30.0 arcsec
Time Series Observation
No Parallel Attachments
No Parallel Attachments

Sequence Observations 2, 4, Non-interruptible

Observation

Proposal 2722, Observation 3: NIRISS Thu Apr 11 21:00:26 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Diagnostics

(NIRISS (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.

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	K2-18	RA: 11 30 14.4311 (172.5601296d) Dec: +07 35 16.13 (7.58781d) Equinox: J2000	Proper Motion RA: -80.47898512176958 mas/yr Proper Motion Dec: -133.00683042964056 mas/yr Parallax: 0.026246877164178752" Epoch of Position: 2016	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[M dwarfs]
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	62532

Template

Subarray	Include Short First Exposure and F277W Exposure?
SUBSTRIP256	true

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	4	648	1	648	17813.831	84979
2	NISRAPID	5	11	1	11	362.829	84979

Special Requirements

Phase 0.99620522679917412 to 0.99747015119944937 with period 32.940045 Days and zero-phase 2457725.551189 HJD
Time Series Observation
No Parallel Attachments