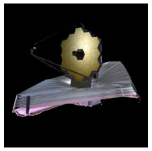

7849 - Meeting their Match: Measuring Cloudy Hot Jupiter Counterparts to Understand the Silicate Cloud Regime with JWST/MIRI

Cycle: 4, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
HATS-72b				
	1	HATS-72b transit	MIRI Low Resolution Spectroscopy	(1) HATS-72b
Kepler-12b				
	2	Kepler-12b transit 1	MIRI Low Resolution Spectroscopy	(2) Kepler-12
	4	Kepler-12b transit 2	MIRI Low Resolution Spectroscopy	(2) Kepler-12
HAT-P-32b				
	6	HAT-P-32b	MIRI Low Resolution Spectroscopy	(3) HAT-P-32

ABSTRACT

Clouds are a fundamental component of all atmospheres, and as such they are key to understanding the physics, chemistry, and overall atmospheric evolution of planets. Silicate clouds are thought to be the most common kind of clouds for a large range of – but not all – hot Jupiter atmospheres. With JWST/MIRI, we are now able to measure the direct absorption of previously inaccessible silicate bonds that manifest from 8-10 microns due to a range of silicate compositions (SiO2, MgSio3, Mg2SiO4, etc.). Detections of silicate clouds have already been made in transmission spectroscopy studies of 3 hot Jupiters; however, these detections do not necessarily fit the prevailing theories about where silicate condensation is expected to occur.

To test whether the current cloud detections are indicative of wider trends for such planets or due to something unique to the conditions of the 3 objects with detected silicate clouds, we will observe the MIRI/LRS transmission spectra of 3 "counterpart" hot Jupiters. These counterparts have similar masses and equilibrium temperatures as those with existing silicate cloud detections, as temperature and mass are the expected first-order determinants of cloud formation and persistence. Our observations will enable us to begin understanding the specific regimes in which silicate clouds dominate, and unlock deeper physical insights into their formation and evolution. These insights will lead to a better understanding of hot Jupiters and brown dwarfs, which also contain such clouds, as well as connect optical to mid-infrared spectral information about aerosol particles for a whole range of worlds.

OBSERVING DESCRIPTION

We will use MIRI/LRS to measure the 5-12 micron transmission spectra of three exoplanets for a total of 49.1 hours We will observe one transit each of HATS-72b and HAT-P-32b, and two transits of Kepler-12b to ensure sufficient signal to detect the relevant cloud species in each atmosphere.

Each target presents multiple transit opportunities throughout Cycle 4.

MIRI/LRS is the only instrument, on the ground or in space, which is capable of obtaining high-precision spectra at the wavelengths required to distinguish different cloud species. Furthermore, each of our targets is designed to compare to an existing MIRI/LRS detection and therefore, it is the only possible instrument to perform this study.

Each observation is designed to cover the entire transit event and pre- and post-transit baseline, allowing for a 1-hour window for schedulability. We have also ensured that at least an hour of pre-transit baseline is observed to account for the settling of the known detector ramp at the start of MIRI TSO observations. In total, each observation lasts for 2x the transit duration of the planet plus an additional hour. This ensures that should our observations begin at the end of the scheduling window, sufficient pre-transit baseline will be obtained to detrend for any settling ramp.

We calculated the necessary phase constraints using ExoCTK, providing a 1hr window for scheduability.

Target acquisition can be performed on each of our targets. Using the JWST ETC we set the group number for TA such that a minimum SNR=150 is achieved using the F560W filter.

None of our targets require position angle orient constraints.

We set the saturation to 0.65 of the ETC full well and will bin the observations in time to ensure we reach the needed signal-to-noise in the reddest wavelengths where the cloud features are prominent.

For HATS-72b, we require 116 groups and 1488 integrations.
For Kepler-12b, we require 596 groups and 399 integrations. Due to the length of the observation, we have split the integrations over two exposures, see below for details.
For HAT-P-32b, we require 109 groups and 1490 integrations.

Due to the number of groups and integrations required to cover the full transit event of Kepler-12b we need to split our observations into two exposures. This results in the split between exposures occuring during the transit event just after ingress and will not disrupt our science goals even if starting at the end of the 60-minute phase window.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	HATS-72b	RA: 22 36 6.3190 (339.0263292d) Dec: -16 59 59.79 (-16.99994d) Equinox: J2000	Proper Motion RA: -108.585 mas/yr Proper Motion Dec: -84.43700000952958 mas/yr Parallax: 0.007888" Epoch of Position: 2000	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.* *User comment: High proper motion star. All numbers checked with Simbad and cross checked with Gaia DR3 catalogue file* *K mag = 9.764* *Category=Star* *Description=[Exoplanet Systems]* *Extended=NO*				
(2)	Kepler-12	RA: 19 04 58.4221 (286.2434254d) Dec: +50 02 25.27 (50.04035d) Equinox: J2000	Proper Motion RA: 3.07 mas/yr Proper Motion Dec: 3.211 mas/yr Parallax: 0.0011351" Epoch of Position: 2000	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.* *User comment: High proper motion star. All numbers checked with Simbad and cross checked with Gaia DR3 catalogue file* *K mag = 12.066* *Category=Star* *Description=[Exoplanet Systems]* *Extended=NO*				
(3)	HAT-P-32	RA: 02 04 10.2774 (31.0428225d) Dec: +46 41 16.21 (46.68784d) Equinox: J2000	Proper Motion RA: -9.763 mas/yr Proper Motion Dec: 3.351 mas/yr Parallax: 0.0034937999999999996" Epoch of Position: 2000	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.* *User comment: High proper motion star. All numbers checked with Simbad and cross checked with Gaia DR3 catalogue file* *K mag = 9.99* *Category=Star* *Description=[Exoplanet Systems]* *Extended=NO*				

Observation

Proposal 7849, Observation 1: HATS-72b transit

Fri Sep 12 06:00:17 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Comments: TA using ETC
HATS-72 with the model set to Castelli & Kurucz K2V 4750K and scaled to Gaia mag of 12.064 I get 27 groups to saturation with Instrument set-up: Aq mode = TA for LRS-Slitless, Filter=F560W, Detector Set-up: subarray = SLITLESSPRISM, groups = 6 (as in APT) gives SNR= 185, brightest pixel = 45k e-.

HATS-72 does not require orient constraints

Diagnostics

(HATS-72b 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
(1)	HATS-72b	RA: 22 36 6.3190 (339.0263292d)	Proper Motion RA: -108.585 mas/yr	
		Dec: -16 59 59.79 (-16.99994d)	Proper Motion Dec: -84.43700000952958 mas/yr	
		Equinox: J2000	Parallax: 0.007888"	
			Epoch of Position: 2000	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.

User comment: High proper motion star. All numbers checked with Simbad and cross checked with Gaia DR3 catalogue file
K mag = 9.764
Category=Star
Description=[Exoplanet Systems]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID
1	SAME	F560W	FAST	6	1	1	0.954	221501

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	Optional ETC ID	Filter
1	FASTR1	6	1	1	1	1	0.954		F560W

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	Optional ETC ID
1	FASTR1	116	1488	1488	1	1	27688.069	221501

Special Requirements

Phase 0.971074031 to 0.9767600253 with period 7.3279474 Days and zero-phase 2458124.28757 HJD
Time Series Observation
No Parallel Attachments

Observation

Proposal 7849, Observation 2: Kepler-12b transit 1 Fri Sep 12 06:00:17 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Comments: TA using ETC
Kepler-12 with the model set to Castelli & Kurucz G0V 6000K and scaled to Gaia mag of 13.3478 I get 200 groups to saturation with Instrument set-up: Aq mode = TA for LRS-Slitless, Filter=F560W, Detector Set-up: subarray = SLITLESSPRISM, groups = 36 (as in APT) gives SNR= 178, brightest pixel = 6k e-.

Kepler-12 does not require orient constraints

Diagnostics

(Kepler-12b transit 1 (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)	Kepler-12	RA: 19 04 58.4221 (286.2434254d)	Proper Motion RA: 3.07 mas/yr	
		Dec: +50 02 25.27 (50.04035d)	Proper Motion Dec: 3.211 mas/yr	
		Equinox: J2000	Parallax: 0.0011351"	
			Epoch of Position: 2000	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.

User comment: High proper motion star. All numbers checked with Simbad and cross checked with Gaia DR3 catalogue file
K mag = 12.066
Category=Star
Description=[Exoplanet Systems]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID
1	SAME	F560W	FAST	36	1	1	5.725	221501

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	Optional ETC ID	Filter
1	FASTR1	36	1	1	1	1	5.725		F560W

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	Optional ETC ID
1	FASTR1	596	200	400	2	1	37978.434	221501

Special Requirements

Phase 0.9369117407 to 0.9463004327 with period 4.4379629 Days and zero-phase 2455004.00915 HJD
Time Series Observation
No Parallel Attachments

2 After 4 by <None specified> to 30 Days

Observation

Proposal 7849, Observation 4: Kepler-12b transit 2

Fri Sep 12 06:00:17 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Comments: TA using ETC
Kepler-12 with the model set to Castelli & Kurucz G0V 6000K and scaled to Gaia mag of 13.3478 I get 200 groups to saturation with Instrument set-up: Aq mode = TA for LRS-Slitless, Filter=F560W, Detector Set-up: subarray = SLITLESSPRISM, groups = 36 (as in APT) gives SNR= 178, brightest pixel = 6k e-.

Kepler-12 does not require orient constraints

Diagnostics

(Kepler-12b transit 2 (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
(2)	Kepler-12	RA: 19 04 58.4221 (286.2434254d)	Proper Motion RA: 3.07 mas/yr	
		Dec: +50 02 25.27 (50.04035d)	Proper Motion Dec: 3.211 mas/yr	
		Equinox: J2000	Parallax: 0.0011351"	
			Epoch of Position: 2000	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.

User comment: High proper motion star. All numbers checked with Simbad and cross checked with Gaia DR3 catalogue file
K mag = 12.066
Category=Star
Description=[Exoplanet Systems]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID
1	SAME	F560W	FAST	36	1	1	5.725	221501

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	Optional ETC ID	Filter
1	FASTR1	36	1	1	1	1	5.725		F560W

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	Optional ETC ID
1	FASTR1	596	200	400	2	1	37978.434	221501

Special Requirements

Phase 0.9369117407 to 0.9463004327 with period 4.4379629 Days and zero-phase 2455004.00915 HJD
Time Series Observation
No Parallel Attachments

2 After 4 by <None specified> to 30 Days

Observation

Proposal 7849, Observation 6: HAT-P-32b

Fri Sep 12 06:00:17 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Comments: TA using ETC
HAT-P-32 with the model set to Castelli & Kurucz G0V 6000K and scaled to Gaia mag of 11.1293 I get 26 groups to saturation with Instrument set-up: Aq mode = TA for LRS-Slitless, Filter=F560W, Detector Set-up: subarray = SLITLESSPRISM, groups = 6 (as in APT) gives SNR= 190, brightest pixel = 47k e-.

HAT-P-32 does not require orient constraints

Diagnostics

(HAT-P-32b (Obs 6)) 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 6:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	HAT-P-32	RA: 02 04 10.2774 (31.0428225d)	Proper Motion RA: -9.763 mas/yr	
		Dec: +46 41 16.21 (46.68784d)	Proper Motion Dec: 3.351 mas/yr	
		Equinox: J2000	Parallax: 0.0034937999999999996"	
			Epoch of Position: 2000	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.

User comment: High proper motion star. All numbers checked with Simbad and cross checked with Gaia DR3 catalogue file
K mag = 9.99
Category=Star
Description=[Exoplanet Systems]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID
1	SAME	F560W	FAST	6	1	1	0.954	221501

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	Optional ETC ID	Filter
1	FASTR1	6	1	1	1	1	0.954		F560W

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	Optional ETC ID
1	FASTR1	109	1490	1490	1	1	26066.497	221501

Special Requirements

Phase 0.9009928195 to 0.9203725905 with period 2.1500082 Days and zero-phase 2456265.154123 HJD
Aperture PA Range 21.83544897 to 165.83544897 Degrees (V3 17.0 to 161.0)
Aperture PA Range 189.83544897 to 261.83544897 Degrees (V3 185.0 to 257.0)
Aperture PA Range 287.83544897 to 1.83544897 Degrees (V3 283.0 to 357.0)
Time Series Observation
No Parallel Attachments