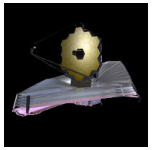

3647 - GJ504 b is really cool: a new atmospheric window into Jupiter's evolution with JWST/MIRI

Cycle: 2, Proposal Category: GO

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
GJ504-B				
	1		MIRI Medium Resolution Spectroscopy	(1) GJ504-B
	2		MIRI Medium Resolution Spectroscopy	(1) GJ504-B
PSF-REF				
	3		MIRI Medium Resolution Spectroscopy	(4) HD-129974

ABSTRACT

The connection between the formation pathway and atmospheric evolution of the young, hot, and widely separated directly-imaged exoplanets and our Solar System gas giants like Jupiter is not well understood. GJ 504 b is the coldest planetary-mass companion (PMC) orbiting a solar-like star on a solar system scale orbit (43 AU) found to date. With an estimated temperature of ~500 K, it is the only PMC that bridges the gap between the population of directly-imaged young exoplanets (~1000K) and our own Jupiter (~130 K). We aim to unveil the mid-infrared spectrum of GJ504b with MIRI/MRS, that is expected to show many pronounced molecular features at these wavelengths, most notably ammonia. Studying the atmosphere will help us understand whether PMCs at lower temperatures still retain the signposts of their hotter counterparts, namely disequilibrium chemistry and clouds, therefore putting the first constrains on this stage of gas giant atmospheric evolution. By measuring the abundances of H2O, CO, CH4 and NH3 we will be able to calculate elemental abundance ratios of C/O and, for the first time, N/O, which in conjunction can provide insights into the formation location and possible migration of the planet. The precision we expect with our measurements of C/O and N/O will be able to distinguish within 3 sigma whether GJ504 b is enriched (like Jupiter), solar, or depleted (like a recent measurement of a cool brown dwarf WISE 1828), potentially showing that it truly is a snapshot of Jupiter in its adolescent years.

OBSERVING DESCRIPTION

We propose to observe the closeby exoplanet system GJ504. The planet is separated by 2.5" making it possible to place the bright (Kmag=4) star out of the MRS FOV. We additionally include a small offset of b from the centre of the FOV in order to place the bright star even further away. In order to achieve our science goals we require an observation of a reference star, offset exactly like GJ504A, in order to subtract the diffraction pattern from

A at the location of b. For sampling the PSF appropriately we chose a 4-pt point source dither, while the dither offsets will also enable the measurement of the background.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	GJ504-B	RA: 13 16 46.0439 (199.1918496d) Dec: +09 25 31.67 (9.42546d) Equinox: J2000	Proper Motion RA: -336.66 mas/yr Proper Motion Dec: 190.58 mas/yr Parallax: 0.057" Epoch of Position: 2015.5	
*Comments: This is a substellar companion to a high proper motion star. The coordinates given here are the predicted position of the **companion in 2024**, specified in the Gaia DR2 frame and epoch, including the measured stellar proper motion.* *The **star** GJ 504 has the ICRS coordinates 13 16 46.1635 +09 25 29.92 at epoch 2015.5 (Gaia DR2).* *As of mid cycle 2 at epoch 2024.0, the offset position of the companion relative to the star is computed to be:* *Separation = 2490.953 ± 11.931 mas, PA = 314.763 ± 0.256 deg* *The computed ICRS coordinates here specify that offset position in the ICRS frame, including the proper motion of the star.* *Category=Star* *Description=[Exoplanets]* *Extended=NO*			
(2)	GJ504-A	RA: 13 16 46.1635 (199.1923479d) Dec: +09 25 29.92 (9.42498d) Equinox: J2000	Proper Motion RA: -336.66 mas/yr Proper Motion Dec: 190.58 mas/yr Parallax: 0.057" Epoch of Position: 2015.5	
*Comments: The **star** GJ 504 has the ICRS coordinates 13 16 46.1635 +09 25 29.92 at epoch 2015.5 (Gaia DR2).* *Category=Star* *Description=[G stars]* *Extended=NO*				
(4)	HD-129974	RA: 14 45 21.5324 (221.3397183d) Dec: +10 35 56.47 (10.59902d) Equinox: J2000	Proper Motion RA: -14.766 mas/yr Proper Motion Dec: 5.072 mas/yr Parallax: 0.005" Epoch of Position: 2015.5	
Comments: Reference star for GJ504 A *HD 129974 coordinates from GAIA DR2* *Category=Star* *Description=[G stars]* *Extended=NO*				

Observation

Proposal 3647, Observation 1

Tue Apr 30 23:00:17 GMT 2024

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Comments: Depending on the visibility window the offsets will need to be adjusted. There is no preference as to which window.

Diagnostics

(Visit 1:1) Warning (Form): Data Excess over lower threshold

(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)	GJ504-B	RA: 13 16 46.0439 (199.1918496d)	Proper Motion RA: -336.66 mas/yr	
		Dec: +09 25 31.67 (9.42546d)	Proper Motion Dec: 190.58 mas/yr	
		Equinox: J2000	Parallax: 0.057"	
			Epoch of Position: 2015.5	

*Comments: This is a substellar companion to a high proper motion star. The coordinates given here are the predicted position of the **companion in 2024**, specified in the Gaia DR2 frame and epoch, including the measured stellar proper motion.*

*The **star** GJ 504 has the ICRS coordinates 13 16 46.1635 +09 25 29.92 at epoch 2015.5 (Gaia DR2).*
As of mid cycle 2 at epoch 2024.0, the offset position of the companion relative to the star is computed to be:
Separation = 2490.953 ± 11.931 mas, PA = 314.763 ± 0.256 deg
The computed ICRS coordinates here specify that offset position in the ICRS frame, including the proper motion of the star.
Category=Star
Description=[Exoplanets]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	2 GJ504-A	FND	FAST	4	1	1	11.1	147153.2

Template

Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
All MRS	NO	FULL	NEUTRAL

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	POINT SOURCE	NEGATIVE

Spectral Elements

#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	LONG(C)	MRSLONG		FASTR1	100	3	1	Dither 1	4	12	3352.248	
1	LONG(C)	MRSSHORT		FASTR1	100	3	1	Dither 1	4	12	3352.248	
2	MEDIUM(B)	MRSLONG		FASTR1	100	3	1	Dither 1	4	12	3352.248	
2	MEDIUM(B)	MRSSHORT		FASTR1	100	3	1	Dither 1	4	12	3352.248	
3	SHORT(A)	MRSLONG		FASTR1	100	3	1	Dither 1	4	12	3352.248	
3	SHORT(A)	MRSSHORT		FASTR1	100	3	1	Dither 1	4	12	3352.248	

Special Requirements	
	Aperture PA Range 120.0 to 135.0 Degrees (V3 120.0 to 135.0) Offset 0.0 arcsec, 0.39 arcsec Same V3 PA 1, 3 Same Aperture PA 1, 2

Observation

Proposal 3647, Observation 2 Tue Apr 30 23:00:17 GMT 2024

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Comments: Depending on the visibility window the offsets will need to be adjusted. There is no preference as to which window.

Diagnostics

(Visit 2:1) Warning (Form): Data Excess over lower threshold

(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)	GJ504-B	RA: 13 16 46.0439 (199.1918496d)	Proper Motion RA: -336.66 mas/yr	
		Dec: +09 25 31.67 (9.42546d)	Proper Motion Dec: 190.58 mas/yr	
		Equinox: J2000	Parallax: 0.057"	
			Epoch of Position: 2015.5	

*Comments: This is a substellar companion to a high proper motion star. The coordinates given here are the predicted position of the **companion in 2024**, specified in the Gaia DR2 frame and epoch, including the measured stellar proper motion.*

*The **star** GJ 504 has the ICRS coordinates 13 16 46.1635 +09 25 29.92 at epoch 2015.5 (Gaia DR2).*
As of mid cycle 2 at epoch 2024.0, the offset position of the companion relative to the star is computed to be:
Separation = 2490.953 ± 11.931 mas, PA = 314.763 ± 0.256 deg
The computed ICRS coordinates here specify that offset position in the ICRS frame, including the proper motion of the star.
Category=Star
Description=[Exoplanets]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	2 GJ504-A	FND	FAST	4	1	1	11.1	147153.2

Template

Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
All MRS	NO	FULL	NEUTRAL

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	POINT SOURCE	NEGATIVE

Spectral Elements

#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	LONG(C)	MRSLONG		FASTR1	100	3	1	Dither 1	4	12	3352.248	
1	LONG(C)	MRSSHORT		FASTR1	100	3	1	Dither 1	4	12	3352.248	
2	MEDIUM(B)	MRSLONG		FASTR1	100	3	1	Dither 1	4	12	3352.248	
2	MEDIUM(B)	MRSSHORT		FASTR1	100	3	1	Dither 1	4	12	3352.248	
3	SHORT(A)	MRSLONG		FASTR1	100	3	1	Dither 1	4	12	3352.248	
3	SHORT(A)	MRSSHORT		FASTR1	100	3	1	Dither 1	4	12	3352.248	

Special Requirements	
	Aperture PA Range 120.0 to 135.0 Degrees (V3 120.0 to 135.0) Offset 0.0 arcsec, 0.39 arcsec Same Aperture PA 1, 2

Observation

Proposal 3647, Observation 3 Tue Apr 30 23:00:17 GMT 2024

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Comments: The reference star observation needs again to be obtained in sequence with the science observations in order to result in optimum PSF subtraction.

Diagnostics

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(4)	HD-129974	RA: 14 45 21.5324 (221.3397183d) Dec: +10 35 56.47 (10.59902d) Equinox: J2000	Proper Motion RA: -14.766 mas/yr Proper Motion Dec: 5.072 mas/yr Parallax: 0.005" Epoch of Position: 2015.5	

Comments: Reference star for GJ504 A

HD 129974 coordinates from GAIA DR2
Category=Star
Description=[G stars]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	4 HD-129974	FND	FAST	4	1	1	11.1	147153.1

Template

Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
All MRS	NO	FULL	NEUTRAL

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	POINT SOURCE	NEGATIVE

Spectral Elements

#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SHORT(A)	MRSLONG		FASTR1	100	1	1	Dither 1	4	4	1110.016	
1	SHORT(A)	MRSSHORT		FASTR1	100	1	1	Dither 1	4	4	1110.016	
2	MEDIUM(B)	MRSLONG		FASTR1	100	1	1	Dither 1	4	4	1110.016	
2	MEDIUM(B)	MRSSHORT		FASTR1	100	1	1	Dither 1	4	4	1110.016	
3	LONG(C)	MRSLONG		FASTR1	100	1	1	Dither 1	4	4	1110.016	
3	LONG(C)	MRSSHORT		FASTR1	100	1	1	Dither 1	4	4	1110.016	

Special Requirements	
	Offset 0.0 arcsec, 2.85 arcsec Same V3 PA 1, 3