



2153 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

Cycle: 1, Proposal Category: GO

INVESTIGATORS

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Dr. Karin Oberg (CoI)	Harvard University

OBSERVATIONS

Folder	Observation	Label	Observing Template	Science Target
HD163296				
	1	HD163296_Roll1	MIRI Coronagraphic Imaging	(1) HD-163296
	6	HD163296_Roll1	MIRI Coronagraphic Imaging	(1) HD-163296
	2	HD163296_Roll2	MIRI Coronagraphic Imaging	(1) HD-163296
	7	HD163296_Roll2	MIRI Coronagraphic Imaging	(1) HD-163296
	3	HD163296-BACKGROUND	MIRI Coronagraphic Imaging	(2) HD-163296-BACKGROUND
	4	IRAS 17555-2235 BACKGROUND	MIRI Coronagraphic Imaging	(4) IRAS-17555-2235-BACKGROUND
	5	IRAS 17555-2235	MIRI Coronagraphic Imaging	(3) IRAS-17555-2235

ABSTRACT

To directly confront planet formation mechanisms, a sample of objects in the earliest stages of their lives, i.e, when they are still embedded in their natal protoplanetary disks, need to be observed and studied. Here we propose to demonstrate a synergistic approach between the Atacama Large Millimeter/submillimeter Array (ALMA) and the James Webb Space Telescope (JWST). ALMA observations can reveal the location of an embedded planet by its influence on the dynamical structure of the protoplanetary disk, while the strength of these perturbations allow for a tight constraint on the mass of the planet. Here we propose to image for the first time an embedded planet in the disk around HD 163296 using the MIRI

instrument onboard JWST. The 2 MJup planet has been detected in several, independent studies and lies 2" north of the host star. JWST/MIRI in coronagraphic mode at 11.4 μm is the only available option to detect such embedded objects for decades to come, as no other instrument has the mid-infrared high-contrast capabilities necessary to overcome the obstacle of disk absorption prevalent at shorter, NIR wavelengths. Given its mass and separation, the planet around HD163296 offers the highest chances of detection and would pave the path for a new and highly efficient exoplanet detection method. Detecting emission from the planet and its surrounding is going to reshape our understanding of planet formation, allowing for direct comparison between formation scenarios.

OBSERVING DESCRIPTION

Here, we aim to directly detect the 2 MJ planet embedded in the protoplanetary disk surrounding HD163296. Based on previous ALMA detections, we know that the planet lies 2" north of the star. These observations have been designed to detect a 0.5 MJ planet (lower bound of mass estimates) at a 5 significance and a 2 MJ planet at a 20 significance in only 5 hours of on-source time. We plan to use the 4-quadrant-phase-mask coronagraph coupled to the F1140C filter to reach the highest possible contrast. No roll angles are requested, as these might introduce self-subtraction of the planet signal.

Also, we plan to observe the reference star 2MASS J17583283-2235474, which was chosen because of its vicinity to the target and its spectrophotometric similarities with it. For reference star observations we plan to use the 9-POINT-SMALL-GRID dithering to maximize the achieved contrast, crucial to detect the planet.

Proposal 2153 - Targets - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	HD-163296	RA: 17 56 21.2797 (269.0886654d) Dec: -21 57 22.48 (-21.95624d) Equinox: J2000	Proper Motion RA: -5.467923715382945E-4 arcsec/yr Proper Motion Dec: -0.03941999996186496 arcsec/yr Parallax: 0.00985259" Epoch of Position: 2015.5	
	Comments: This is the primary science target. It has a K magnitude of 5.5 mag. This corresponds to 8.3 Jy. Category=Star Description=[Circumstellar disks, Herbig Ae/Be stars] Extended=NO				
	(2)	HD-163296-BACKGROUND	RA: 17 56 36.3900 (269.1516250d) Dec: -21 58 34.70 (-21.97631d) Equinox: J2000		
	Comments: Background observations to correct for glow sticks Category=Calibration Description=[Coronagraphic]				
	(3)	IRAS-17555-2235	RA: 17 58 32.8564 (269.6369017d) Dec: -22 35 47.36 (-22.59649d) Equinox: J2000	Proper Motion RA: 6.439683563217475E-4 sec of time/yr Proper Motion Dec: -0.0056899999208326335 arcsec/yr Parallax: 0.00119945" Epoch of Position: 2015.5	
	Comments: IRAS 17555-2235 is the reference target of this program. It has a K magnitude of 3.2 mag. This corresponds to 3.5 Jy. Category=Star Description=[M stars] Extended=NO				
	(4)	IRAS-17555-2235-BACKGROUND	RA: 17 56 36.3900 (269.1516250d) Dec: -21 58 34.70 (-21.97631d) Equinox: J2000		
Comments: Background observations to correct for glow sticks Category=Calibration Description=[Coronagraphic]					

Proposal 2153 - Observation 1 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

Observation	Proposal 2153, Observation 1: HD163296_Roll1												Tue Sep 19 16:02:13 GMT 2023
	Diagnostic Status: Warning												
	Observing Template: MIRI Coronagraphic Imaging												
	Background Observations:[HD163296_Roll2 (Obs 2), HD163296-BACKGROUND (Obs 3)]												
	Comments: It would be ideal to maximize the PA offset range. Thus, if possible, please schedule the observation when PA offset can be ~11-14 deg. This would make PSF subtraction more effective at smaller separation.												
Diagnostics	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.												
	(HD163296_Roll1 (Obs 1)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.												
Fixed Targets	#	Name	Target Coordinates				Targ. Coord. Corrections				Miscellaneous		
	(1)	HD-163296	RA: 17 56 21.2797 (269.0886654d) Dec: -21 57 22.48 (-21.95624d) Equinox: J2000				Proper Motion RA: -5.467923715382945E-4 arcsec/yr Proper Motion Dec: -0.03941999996186496 arcsec/yr Parallax: 0.00985259" Epoch of Position: 2015.5						
	Comments: This is the primary science target. It has a K magnitude of 5.5 mag. This corresponds to 8.3 Jy.												
	Category=Star												
	Description=[Circumstellar disks, Herbig Ae/Be stars] Extended=NO												
Acquisition	#	Target	Filter	Quadrant	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID			
	1	SAME	FND	1	FAST	6	1	1	1.438	62934.1			
Template	Repeat observation												
	NO												
Dithers	#	Dither Type											
	1	NONE											
Spectral Elements	#	Coron Mask/Filter	Subarray	Mask	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	4QPM/F1140C	MASK1140	4QPM	F1140C	FASTR1	200	172	1	1	172	8285.977	

Proposal 2153 - Observation 1 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

PSF References	IRAS 17555-2235 (Obs 5) (PSF Reference; Filters [F1140C]) Additional Justification: false
Special Requirements	Aperture PA Range 90 to 101 Degrees (V3 85.16455103 to 96.16455103) No Parallel Attachments Sequence Observations 1, 2, 3, 4, 5, Non-interruptible Aperture PA Offset 1 from 2 by 9 to 14 Degrees (Same offsets in V3)

Proposal 2153 - Observation 6 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

Observation	Proposal 2153, Observation 6: HD163296_Roll1												Tue Sep 19 16:02:13 GMT 2023
	Diagnostic Status: Warning												
	Observing Template: MIRI Coronagraphic Imaging												
	Background Observations:[] Comments: It would be ideal to maximize the PA offset range. Thus, if possible, please schedule the observation when PA offset can be ~11-14 deg. This would make PSF subtraction more effective at smaller separation.												
Diagnostics	(HD163296_Roll1 (Obs 6)) Warning (Form): PSF Reference observations should be SEQ NON-INT.												
	(HD163296_Roll1 (Obs 6)) Warning (Form): Science observations should be linked to at least one other compatible science observation by an Aperture PA Offset of 1-14 degrees												
	(HD163296_Roll1 (Obs 6)) Warning (Form): This target should have similar background exposures that are linked in a non-interruptible sequence.												
	(Visit 6:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.												
Fixed Targets	#	Name	Target Coordinates				Targ. Coord. Corrections				Miscellaneous		
	(1)	HD-163296	RA: 17 56 21.2797 (269.0886654d) Dec: -21 57 22.48 (-21.95624d) Equinox: J2000				Proper Motion RA: -5.467923715382945E-4 arcsec/yr Proper Motion Dec: -0.03941999996186496 arcsec/yr Parallax: 0.00985259" Epoch of Position: 2015.5						
	Comments: This is the primary science target. It has a K magnitude of 5.5 mag. This corresponds to 8.3 Jy.												
	Category=Star Description=[Circumstellar disks, Herbig Ae/Be stars] Extended=NO												
Acquisition	#	Target	Filter	Quadrant	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID			
	1	SAME	FND	1	FAST	6	1	1	1.438	62934.1			
Template	Repeat observation												
	NO												
Dithers	#	Dither Type											
	1	NONE											
Spectral Elements	#	Coron Mask/Filter	Subarray	Mask	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	4QPM/F1140C	MASK1140	4QPM	F1140C	FASTR1	200	172	1	1	172	8285.977	

Proposal 2153 - Observation 6 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

PSF References	IRAS 17555-2235 (Obs 5) (PSF Reference; Filters [F1140C]) Additional Justification: false
Special Requirements	Aperture PA Range 90 to 101 Degrees (V3 85.16455103 to 96.16455103) No Parallel Attachments

Proposal 2153 - Observation 2 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

Observation	Proposal 2153, Observation 2: HD163296_Roll2												Tue Sep 19 16:02:13 GMT 2023
	Diagnostic Status: Warning												
	Observing Template: MIRI Coronagraphic Imaging												
	Background Observations:[HD163296_Roll1 (Obs 1), HD163296-BACKGROUND (Obs 3)]												
Diagnostics	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.												
	(HD163296_Roll2 (Obs 2)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.												
Fixed Targets	#	Name	Target Coordinates				Targ. Coord. Corrections				Miscellaneous		
	(1)	HD-163296	RA: 17 56 21.2797 (269.0886654d) Dec: -21 57 22.48 (-21.95624d) Equinox: J2000				Proper Motion RA: -5.467923715382945E-4 arcsec/yr Proper Motion Dec: -0.03941999996186496 arcsec/yr Parallax: 0.00985259" Epoch of Position: 2015.5						
	Comments: This is the primary science target. It has a K magnitude of 5.5 mag. This corresponds to 8.3 Jy.												
	Category=Star												
	Description=[Circumstellar disks, Herbig Ae/Be stars] Extended=NO												
Acquisition	#	Target	Filter	Quadrant	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID			
	1	SAME	FND	1	FAST	6	1	1	1.438	62934.1			
Template	Repeat observation												
	NO												
Dithers	#	Dither Type											
	1	NONE											
Spectral Elements	#	Coron Mask/Filter	Subarray	Mask	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	4QPM/F1140C	MASK1140	4QPM	F1140C	FASTR1	200	172	1	1	172	8285.977	

Proposal 2153 - Observation 2 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

PSF References	IRAS 17555-2235 (Obs 5) (PSF Reference; Filters [F1140C]) Additional Justification: false
Special Requirements	No Parallel Attachments Sequence Observations 1, 2, 3, 4, 5, Non-interruptible Aperture PA Offset 1 from 2 by 9 to 14 Degrees (Same offsets in V3)

Proposal 2153 - Observation 7 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

Observation	Proposal 2153, Observation 7: HD163296_Roll2												Tue Sep 19 16:02:13 GMT 2023
	Diagnostic Status: Warning												
	Observing Template: MIRI Coronagraphic Imaging												
	Background Observations:[]												
Diagnostics	(HD163296_Roll2 (Obs 7)) Warning (Form): PSF Reference observations should be SEQ NON-INT.												
	(HD163296_Roll2 (Obs 7)) Warning (Form): Science observations should be linked to at least one other compatible science observation by an Aperture PA Offset of 1-14 degrees												
	(HD163296_Roll2 (Obs 7)) Warning (Form): This target should have similar background exposures that are linked in a non-interruptible sequence.												
	(Visit 7:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.												
Fixed Targets	#	Name	Target Coordinates				Targ. Coord. Corrections			Miscellaneous			
	(1)	HD-163296	RA: 17 56 21.2797 (269.0886654d)				Proper Motion RA: -5.467923715382945E-4 arcsec/yr			Epoch of Position: 2015.5			
			Dec: -21 57 22.48 (-21.95624d)				Proper Motion Dec: -0.03941999996186496 arcsec/yr						
			Equinox: J2000				Parallax: 0.00985259"						
	Comments: This is the primary science target. It has a K magnitude of 5.5 mag. This corresponds to 8.3 Jy.												
Category=Star													
Description=[Circumstellar disks, Herbig Ae/Be stars]													
Extended=NO													
Acquisition	#	Target	Filter	Quadrant	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID			
	1	SAME	FND	1	FAST	6	1	1	1.438	62934.1			
Template	Repeat observation												
	NO												
Dithers	#	Dither Type											
	1	NONE											
Spectral Elements	#	Coron Mask/Filter	Subarray	Mask	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	4QPM/F1140C	MASK1140	4QPM	F1140C	FASTR1	200	172	1	1	172	8285.977	

Proposal 2153 - Observation 7 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

PSF References	IRAS 17555-2235 (Obs 5) (PSF Reference; Filters [F1140C]) Additional Justification: false
Special Requirements	No Parallel Attachments

Proposal 2153 - Observation 3 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

Observation	Proposal 2153, Observation 3: HD163296-BACKGROUND Tue Sep 19 16:02:13 GMT 2023												
	Diagnostic Status: Warning Observing Template: MIRI Coronagraphic Imaging Background Observation For: [HD163296_Roll1 (Obs 1), HD163296_Roll2 (Obs 2)]												
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			
	(2)	HD-163296-BACKGROUND	RA: 17 56 36.3900 (269.1516250d) Dec: -21 58 34.70 (-21.97631d) Equinox: J2000 <i>Comments: Background observations to correct for glow sticks</i> <i>Category=Calibration</i> <i>Description=[Coronagraphic]</i>										
Acquisition	#	Target											
	1	NONE											
Template	AcqFilter	Repeat observation				Background Quadrant							
		YES				1							
Dithers	#	Dither Type											
	1	BACKGROUND											
Spectral Elements	#	Coron Mask/Filter	Subarray	Mask	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	4QPM/F1140C	MASK1140	4QPM	F1140C	FASTR1	200	172	1	2	344	16571.955	
PSF References	Additional Justification: false												

Proposal 2153 - Observation 3 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

Special Requirements	No Parallel Attachments
	Sequence Observations 1, 2, 3, 4, 5, Non-interruptible

Proposal 2153 - Observation 4 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

Observation	Proposal 2153, Observation 4: IRAS 17555-2235 BACKGROUND												Tue Sep 19 16:02:13 GMT 2023	
	Diagnostic Status: Warning													
	Observing Template: MIRI Coronagraphic Imaging													
	Background Observation For: [IRAS 17555-2235 (Obs 5)]													
Diagnostics	(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)	IRAS-17555-2235-BACKGROUND		RA: 17 56 36.3900 (269.1516250d) Dec: -21 58 34.70 (-21.97631d) Equinox: J2000										
	Comments: Background observations to correct for glow sticks													
	Category=Calibration Description=[Coronagraphic]													
Acquisition	#	Target												
	1	NONE												
Template	AcqFilter	Repeat observation						Background Quadrant						
		YES						1						
Dithers	#	Dither Type												
	1	BACKGROUND												
Spectral Elements	#	Coron Mask/Filter	Subarray	Mask	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1	4QPM/F1140C	MASK1140	4QPM	F1140C	FASTR1	200	2	1	2	4	192.223		
PSF References	Additional Justification: false													

Proposal 2153 - Observation 4 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

Special Requirements	No Parallel Attachments
	Sequence Observations 1, 2, 3, 4, 5, Non-interruptible

Proposal 2153 - Observation 5 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

Observation	Proposal 2153, Observation 5: IRAS 17555-2235												Tue Sep 19 16:02:13 GMT 2023	
	Diagnostic Status: Warning													
	Observing Template: MIRI Coronagraphic Imaging													
	Background Observations:[IRAS 17555-2235 BACKGROUND (Obs 4)]													
Diagnostics	(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.													
Fixed Targets	#	Name		Target Coordinates			Targ. Coord. Corrections				Miscellaneous			
	(3)	IRAS-17555-2235		RA: 17 58 32.8564 (269.6369017d) Dec: -22 35 47.36 (-22.59649d) Equinox: J2000			Proper Motion RA: 6.439683563217475E-4 sec of time/yr Proper Motion Dec: -0.0056899999208326335 arcsec/yr Parallax: 0.00119945" Epoch of Position: 2015.5							
	Comments: IRAS 17555-2235 is the reference target of this program. It has a K magnitude of 3.2 mag. This corresponds to 3.5 Jy.													
	Category=Star Description=[M stars] Extended=NO													
Acquisition	#	Target		Filter	Quadrant	Readout Pattern	Groups/Int	Integrations/Exp		Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID		
	1	SAME		FND	1	FAST	4	1		1	0.959	62934.2		
Template	Repeat observation NO													
Dithers	#	Dither Type												
	1	9-POINT-SMALL-GRID												
Spectral Elements	#	Coron Mask/Filter	Subarray	Mask	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1	4QPM/F1140C	MASK1140	4QPM	F1140C	FASTR1	200	2	1	9	18	865.005		

Proposal 2153 - Observation 5 - Detecting a Young 2 Jupiter Mass Planet Embedded in the Disk of HD 163296

PSF References	PSF Reference: true
Special Requirements	No Parallel Attachments Sequence Observations 1, 2, 3, 4, 5, Non-interruptible