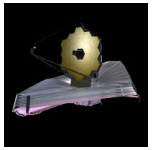

2540 - Investigating the Disk-Planet Interaction in the HD 163296 System with JWST

Cycle: 1, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
Dr. Luca Ricci (PI)	**The University Corporation**
Dr. Marie Ygouf (CoI)	Jet Propulsion Laboratory
Dr. Dimitri Mawet (CoI)	California Institute of Technology
Dr. Vanessa Bailey (CoI)	Jet Propulsion Laboratory
Dr. Massimo Robberto (CoI)	The Johns Hopkins University
Dr. Sean M Andrews (CoI)	Smithsonian Institution Astrophysical Observatory
Dr. Laura Perez (CoI)	Universidad de Chile
Dr. Andrea Isella (CoI)	Rice University
Prof. Cornelis Dullemond (CoI) (ESA Member)	Universitat Heidelberg
Prof. Zhaohuan Zhu (CoI)	University of Nevada - Las Vegas
Shangjia Zhang (CoI)	University of Nevada - Las Vegas
Dr. Jane Huang (CoI)	Columbia University in the City of New York
Sara Tatiana Gallagher (CoI)	California State University - Northridge
Garreth Ruane (CoI)	Jet Propulsion Laboratory

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	NIRCam Coron. MASK210R F200W Roll 1	NIRCam Coronagraphic Imaging	(1) HD-163296
	2	NIRCam Coron. MASK430R F410M Roll 1	NIRCam Coronagraphic Imaging	(1) HD-163296

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
	3	NIRCam Coron. MAS K430R F410M Roll 2	NIRCam Coronagraphic Imaging	(1) HD-163296
	4	NIRCam Coron. MAS K210R F200W Roll 2	NIRCam Coronagraphic Imaging	(1) HD-163296

ABSTRACT

We propose JWST/NIRCam observations of the planet-forming disk orbiting the young Herbig Ae star HD 163296. Recent high resolution ALMA observations have unveiled concentric annular gaps in the distribution of mm-sized pebbles at angular distances of 0.1, 0.5, 0.9, 1.5 arcsec from the central star. The two outer dust gaps show depletion also in CO gas, suggesting the possible presence of Jupiter-mass giant planets to gravitationally clear material out of their orbit. If so, also micron-sized grains should be severely depleted at the location of the two outer gaps. Moreover, the analysis of high angular and spectral resolution observations with ALMA of the CO molecular line emission have found significant discrepancies from the Keplerian rotation of the disk. Also these kinematical features have been attributed to the interaction with giant planets that would affect the 3D velocity of gas in the disk, but this scenario still lacks emipirical confirmation.

This hypothesis can be directly tested via the proposed NIRCam coronagraphic observations, which have the potential to detect the emission from these young giant planets.

Given the angular separations and characteristics of the multiple substructures detected in both the density and kinematics of this disk, HD 163296 represents an ideal testbed system to demonstrate the potential of JWST, in synergy with ALMA, to test models of the disk-planet interaction and planet formation.

OBSERVING DESCRIPTION

The discovery of thousands of exoplanets over the last couple of decades has shown that the birth of planets is a very efficient process in nature. However, the physical mechanisms responsible for their formation and evolution are still poorly understood. Although theoretical investigations of the disk-planet interaction have been conducted for several decades, this theory still needs empirical validation.

We propose JWST/NIRCam observations of the planet-forming disk orbiting the young Herbig Ae star HD 163296. Recent high resolution ALMA observations have unveiled concentric annular gaps in the gas and dust density distribution as well as kinematical features which have been attributed to the interaction with giant planets, but this scenario still lacks emipirical confirmation.

This hypothesis can be directly tested via the proposed NIRCam coronagraphic observations, which have the potential to detect the emission from these young giant planets.

Given the angular separations and characteristics of the multiple substructures detected in both the density and kinematics of this disk, HD 163296

represents an ideal testbed source to demonstrate the potential of JWST, in synergy with ALMA, to test models of the disk-planet interaction and planet formation.

We will perform coronagraphic observations with the MASK430R mask and F410M filter which give the best opportunities to detect emission from young giant planets at the locations of the disk substructures detected with ALMA. We will also observe the system with the F200W filter to be able to distinguish planetary emission from possible emission/scattering light from dust in the disk. PSF subtraction will be performed via Angular Differential Imaging with two roll angles and no reference stars, as the strong infrared excess observed in HD 163296 precludes the possibility of using nearby stars for accurate PSF subtraction.

Proposal 2540 - Targets - Investigating the Disk-Planet Interaction in the HD 163296 System with JWST

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	HD-163296	RA: 17 56 21.2880 (269.0887000d)	Proper Motion RA: -7.607 mas/yr	
		Dec: -21 57 21.87 (-21.95607d)	Proper Motion Dec: -39.420 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

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

The K-band mag of HD 163296 is 4.779
Category=Star
Description=[Circumstellar clouds, Debris disks, Exoplanet Systems, Exoplanets]

Observation

Proposal 2540, Observation 1: NIRCam Coron. MASK210R F200W Roll 1 Mon Jul 17 15:08:45 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRCam Coronagraphic Imaging

Diagnostics

(NIRCam Coron. MASK210R F200W Roll 1 (Obs 1)) Warning (Form): By checking 'Additional justification', this observation is identified as part of a self reference survey. Remember to provide justification for this in the technical description text of your PDF attachment.

(NIRCam Coron. MASK210R F200W Roll 1 (Obs 1)) Warning (Form): Science observations should be linked to at least one other compatible science observation by an Aperture PA Offset of 1-14 degrees

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

(NIRCam Coron. MASK210R F200W Roll 1 (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 21.2880 (269.0887000d)	Proper Motion RA: -7.607 mas/yr	
		Dec: -21 57 21.87 (-21.95607d)	Proper Motion Dec: -39.420 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

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

The K-band mag of HD 163296 is 4.779
Category=Star
Description=[Circumstellar clouds, Debris disks, Exoplanet Systems, Exoplanets]

Acquisition

#	Target	Filter	Target Brightness	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	F210M	BRIGHT (ND Square)	RAPID	9	1	1	1.825	54407.4

Template

Module	Coronagraphic Mask	Obtain Astrometric Confirmation Images?	Subarray	Dither Pattern
A	MASK210R	true	SUB640A210R	5-POINT-BOX

Confirmation

#	Conf. Readout Pattern	Conf. Groups/Int	Conf. Integrations/Exp	Conf. Total Integrations	Conf. Total Exposure Time	Conf. Total Dithers
1	RAPID	5	1	1	53.684	1

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F200W	F410M	RAPID	7	55	5	275	9214.48	158762.9

PSF References	NIRCam Coron. MASK210R F200W Roll 2 (Obs 4) (Filters [F200W/F410M]) Additional Justification: true
Special Requirements	Offset 0.007 arcsec, -0.002 arcsec No Parallel Attachments Sequence Observations 1, 2, 3, 4, Non-interruptible Aperture PA Offset 1 from 3 by 10 to 14 Degrees (V3 10.17242306 to 14.17242306) Same Aperture PA 1, 2 (V3 PAs differ)

Observation

Proposal 2540, Observation 2: NIRCam Coron. MASK430R F410M Roll 1 Mon Jul 17 15:08:45 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRCam Coronagraphic Imaging

Diagnostics

(NIRCam Coron. MASK430R F410M Roll 1 (Obs 2)) Warning (Form): By checking 'Additional justification', this observation is identified as part of a self reference survey. Remember to provide justification for this in the technical description text of your PDF attachment.

(NIRCam Coron. MASK430R F410M Roll 1 (Obs 2)) Warning (Form): Science observations should be linked to at least one other compatible science observation by an Aperture PA Offset of 1-14 degrees

(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(NIRCam Coron. MASK430R F410M Roll 1 (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 21.2880 (269.0887000d)	Proper Motion RA: -7.607 mas/yr	
		Dec: -21 57 21.87 (-21.95607d)	Proper Motion Dec: -39.420 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

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

The K-band mag of HD 163296 is 4.779
Category=Star
Description=[Circumstellar clouds, Debris disks, Exoplanet Systems, Exoplanets]

Acquisition

#	Target	Filter	Target Brightness	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	F335M	BRIGHT (ND Square)	RAPID	17	1	1	0.905	54407.3

Template

Module	Coronagraphic Mask	Obtain Astrometric Confirmation Images?	Subarray	Dither Pattern
A	MASK430R	true	SUB320A430R	5-POINT-BOX

Confirmation

#	Conf. Readout Pattern	Conf. Groups/Int	Conf. Integrations/Exp	Conf. Total Integrations	Conf. Total Exposure Time	Conf. Total Dithers
1	RAPID	5	1	1	53.684	1

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F200W	F410M	MEDIUM8	6	32	5	160	10095.014	158762.12

PSF References	NIRCam Coron. MASK430R F410M Roll 2 (Obs 3) (Filters [F200W/F410M]) Additional Justification: true
Special Requirements	Offset 0.017 arcsec, -0.015 arcsec No Parallel Attachments Sequence Observations 1, 2, 3, 4, Non-interruptible Same Aperture PA 1, 2 (V3 PAs differ)

Observation

Proposal 2540, Observation 3: NIRCam Coron. MASK430R F410M Roll 2 Mon Jul 17 15:08:45 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRCam Coronagraphic Imaging

Diagnostics

(NIRCam Coron. MASK430R F410M Roll 2 (Obs 3)) Warning (Form): By checking 'Additional justification', this observation is identified as part of a self reference survey. Remember to provide justification for this in the technical description text of your PDF attachment.

(NIRCam Coron. MASK430R F410M Roll 2 (Obs 3)) Warning (Form): Science observations should be linked to at least one other compatible science observation by an Aperture PA Offset of 1-14 degrees

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

(NIRCam Coron. MASK430R F410M Roll 2 (Obs 3)) 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 21.2880 (269.0887000d)	Proper Motion RA: -7.607 mas/yr	
		Dec: -21 57 21.87 (-21.95607d)	Proper Motion Dec: -39.420 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

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

The K-band mag of HD 163296 is 4.779
Category=Star
Description=[Circumstellar clouds, Debris disks, Exoplanet Systems, Exoplanets]

Acquisition

#	Target	Filter	Target Brightness	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	F335M	BRIGHT (ND Square)	RAPID	17	1	1	0.905	54407.3

Template

Module	Coronagraphic Mask	Obtain Astrometric Confirmation Images?	Subarray	Dither Pattern
A	MASK430R	true	SUB320A430R	5-POINT-BOX

Confirmation

#	Conf. Readout Pattern	Conf. Groups/Int	Conf. Integrations/Exp	Conf. Total Integrations	Conf. Total Exposure Time	Conf. Total Dithers
1	RAPID	5	1	1	53.684	1

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F200W	F410M	MEDIUM8	6	32	5	160	10095.014	158762.13

PSF References	NIRCam Coron. MASK430R F410M Roll 1 (Obs 2) (Filters [F200W/F410M]) Additional Justification: true
Special Requirements	Offset 0.017 arcsec, -0.015 arcsec No Parallel Attachments Sequence Observations 1, 2, 3, 4, Non-interruptible Aperture PA Offset 1 from 3 by 10 to 14 Degrees (V3 10.17242306 to 14.17242306) Same Aperture PA 3, 4 (V3 PAs differ)

Observation

Proposal 2540, Observation 4: NIRCam Coron. MASK210R F200W Roll 2 Mon Jul 17 15:08:45 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRCam Coronagraphic Imaging

Diagnostics

(NIRCam Coron. MASK210R F200W Roll 2 (Obs 4)) Warning (Form): By checking 'Additional justification', this observation is identified as part of a self reference survey. Remember to provide justification for this in the technical description text of your PDF attachment.

(NIRCam Coron. MASK210R F200W Roll 2 (Obs 4)) Warning (Form): Science observations should be linked to at least one other compatible science observation by an Aperture PA Offset of 1-14 degrees

(Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(NIRCam Coron. MASK210R F200W Roll 2 (Obs 4)) 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 21.2880 (269.0887000d)	Proper Motion RA: -7.607 mas/yr	
		Dec: -21 57 21.87 (-21.95607d)	Proper Motion Dec: -39.420 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

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

The K-band mag of HD 163296 is 4.779
Category=Star
Description=[Circumstellar clouds, Debris disks, Exoplanet Systems, Exoplanets]

Acquisition

#	Target	Filter	Target Brightness	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	F210M	BRIGHT (ND Square)	RAPID	9	1	1	1.825	54407.4

Template

Module	Coronagraphic Mask	Obtain Astrometric Confirmation Images?	Subarray	Dither Pattern
A	MASK210R	true	SUB640A210R	5-POINT-BOX

Confirmation

#	Conf. Readout Pattern	Conf. Groups/Int	Conf. Integrations/Exp	Conf. Total Integrations	Conf. Total Exposure Time	Conf. Total Dithers
1	RAPID	5	1	1	53.684	1

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F200W	F410M	RAPID	7	55	5	275	9214.48	158762.10

PSF References	NIRCam Coron. MASK210R F200W Roll 1 (Obs 1) (Filters [F200W/F410M]) Additional Justification: true
Special Requirements	Offset 0.007 arcsec, -0.002 arcsec No Parallel Attachments Sequence Observations 1, 2, 3, 4, Non-interruptible Same Aperture PA 3, 4 (V3 PAs differ)