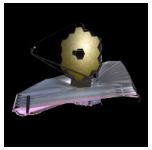

4876 - Time-resolved protoplanetary disk physics in DQ Tau

Cycle: 3, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
DQ Tau epoch 1				
	1	DQ Tau MIRI MRS	MIRI Medium Resolution Spectroscopy	(1) DQ-Tau
	2	DQ Tau background MIRI MRS	MIRI Medium Resolution Spectroscopy	(2) DQ-Tau-background
DQ Tau epoch 2				
	3	DQ Tau MIRI MRS	MIRI Medium Resolution Spectroscopy	(1) DQ-Tau
	4	DQ Tau background MIRI MRS	MIRI Medium Resolution Spectroscopy	(2) DQ-Tau-background
DQ Tau epoch 3				
	5	DQ Tau MIRI MRS	MIRI Medium Resolution Spectroscopy	(1) DQ-Tau
	6	DQ Tau background MIRI MRS	MIRI Medium Resolution Spectroscopy	(2) DQ-Tau-background
DQ Tau epoch 4				
	7	DQ Tau MIRI MRS	MIRI Medium Resolution Spectroscopy	(1) DQ-Tau
	8	DQ Tau background MIRI MRS	MIRI Medium Resolution Spectroscopy	(3) DQ-Tau-background-new

ABSTRACT

Planet-forming disks are no longer thought of as static structures. The accretion of mass from the disk onto the forming star is highly variable on timescales of hours to days, and the changing X-ray, UV, and optical radiation may have profound effects on the physical and chemical properties of the disk material, right when planetary cores are being assembled or when the planets are accreting their primary atmospheres. Most T Tauri stars vary stochastically, therefore variations in their disks are only discovered serendipitously. The lack of a systematic study on disk variability in the infrared regime, where material forming terrestrial planets mainly emit, severely limits our understanding on how disks react to variable irradiation. DQ Tau, thanks to its periodically changing accretion rate modulated by a central close eccentric binary, provides a unique opportunity for exactly such a study. This system's X-ray, UV, and optical brightness is known to increase during (almost) every periastron due to magnetic interactions and pulsed accretion. Earlier Spitzer/IRS data shows definite changes in the continuum flux and marginal (few percent) variability in molecular emission features in the disk. Consistently with this, our simulations of changing disk temperature also predict similar changes in the spectrum. After evaluating the repeatability of JWST MIRI observations, we demonstrate that our carefully planned 4-epoch monitoring of DQ Tau coupled with detailed modeling has the potential to reveal the physical (temperature, emitting area) and chemical (abundances) changes the disk experiences as a consequence of variable accretion and high-energy irradiation.

OBSERVING DESCRIPTION

In this project, we will conduct a 4-epoch mid-infrared spectoscopic monitoring of DQ Tau, a pre-main sequence binary experiencing periodic accretion related brightenings. The observations are time-critical: by targeting three consecutive periastrons of the 15.8-day period binary and one out-of-periastron epoch, we plan to catch the system in various accretion states. Time constraints were made for the 2025 visibility window instead of the 2024 visibility window to avoid overlap with the micrometeoroid avoidance zone.

We will use three different grating settings to cover the whole 5-28 micron wavelength range with MIRI MRS. We will use target acquisition with the Neutral Density Filter to center our target precisely and observe a separate background, in order to obtain the best fringe correction and repeatability of the spectro-photometric calibration for our target. The recommended 4-point dither pattern optimized for point sources is used for the science target, while a 2-point dither pattern optimized for background observations is used for the sky background. The science target and background observations are linked with non-interruptible links. Our target is too bright for the SLOWR1 read-out, therefore we will use FASTR1. Simultaneous imaging is disabled to avoid exceeding the threshold for data downlink.

Proposal 4876 - Targets - Time-resolved protoplanetary disk physics in DQ Tau

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	DQ-Tau	RA: 04 46 53.0575 (71.7210729d) Dec: +17 00 0.14 (17.00004d) Equinox: J2000	Proper Motion RA: 4.906 mas/yr Proper Motion Dec: -13.29599997461628 mas/yr Epoch of Position: 2000	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[M dwarfs, Multiple stars, Pre-main sequence stars, Protoplanetary disks, T Tauri stars]* *Extended=NO*				
(2)	DQ-Tau-background	RA: 04 46 59.7300 (71.7488750d) Dec: +17 00 38.20 (17.01061d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000	
Comments: *Category=Calibration* *Description=[Telescope/sky background]* *Extended=YES*				
(3)	DQ-Tau-background-new	RA: 04 47 0.2900 (71.7512083d) Dec: +17 00 38.20 (17.01061d) Equinox: J2000	Epoch of Position: 2000	
Comments: *Category=Calibration* *Description=[Telescope/sky background]* *Extended=YES*				

Observation

Proposal 4876, Observation 1: DQ Tau MIRI MRS Thu Feb 06 17:00:30 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[DQ Tau background MIRI MRS (Obs 2)]

Diagnostics

(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)	DQ-Tau	RA: 04 46 53.0575 (71.7210729d)	Proper Motion RA: 4.906 mas/yr	
		Dec: +17 00 0.14 (17.00004d)	Proper Motion Dec: -13.29599997461628 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[M dwarfs, Multiple stars, Pre-main sequence stars, Protoplanetary disks, T Tauri stars]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	FND	FAST	4	1	1	11.1	173498

Template

Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
All MRS	NO	FULL	Allow Auto Reorder

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	25	5	1	Dither 1	4	20	1431.921	173498
1	SHORT(A)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
2	MEDIUM(B)	MRSLONG		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
2	MEDIUM(B)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
3	LONG(C)	MRSLONG		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
3	LONG(C)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498

Special Requirements	
	Between Dates 28-JAN-2025:19:55:12 and 31-JAN-2025:19:55:12 Sequence Observations 1, 2, Non-interruptible

Observation

Proposal 4876, Observation 2: DQ Tau background MIRI MRS Thu Feb 06 17:00:30 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: [DQ Tau MIRI MRS (Obs 1)]

Diagnostics

(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)	DQ-Tau-background	RA: 04 46 59.7300 (71.7488750d)	Proper Motion RA: 0	
		Dec: +17 00 38.20 (17.01061d)	Proper Motion Dec: 0	
		Equinox: J2000	Epoch of Position: 2000	

Comments:
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
FND	All MRS	NO	FULL	Allow Auto Reorder

Dithers

#	Dither Type	Optimized For	Direction
1	2-Point	BACKGROUND	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	25	5	1	Dither 1	2	10	715.96	
1	SHORT(A)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	
2	MEDIUM(B)	MRSLONG		FASTR1	25	5	1	Dither 1	2	10	715.96	
2	MEDIUM(B)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	
3	LONG(C)	MRSLONG		FASTR1	25	5	1	Dither 1	2	10	715.96	
3	LONG(C)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	

Special Requirements	Sequence Observations 1, 2, Non-interruptible

Observation

Proposal 4876, Observation 3: DQ Tau MIRI MRS Thu Feb 06 17:00:30 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[DQ Tau background MIRI MRS (Obs 4)]

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
(1)	DQ-Tau	RA: 04 46 53.0575 (71.7210729d)	Proper Motion RA: 4.906 mas/yr	
		Dec: +17 00 0.14 (17.00004d)	Proper Motion Dec: -13.29599997461628 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[M dwarfs, Multiple stars, Pre-main sequence stars, Protoplanetary disks, T Tauri stars]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	FND	FAST	4	1	1	11.1	173498

Template

Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
All MRS	NO	FULL	Allow Auto Reorder

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	25	5	1	Dither 1	4	20	1431.921	173498
1	SHORT(A)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
2	MEDIUM(B)	MRSLONG		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
2	MEDIUM(B)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
3	LONG(C)	MRSLONG		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
3	LONG(C)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498

Special Requirements	
	Between Dates 07-FEB-2025:03:21:36 and 10-FEB-2025:03:21:36 Sequence Observations 3, 4, Non-interruptible

Observation

Proposal 4876, Observation 4: DQ Tau background MIRI MRS Thu Feb 06 17:00:30 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: [DQ Tau MIRI MRS (Obs 3)]

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
(2)	DQ-Tau-background	RA: 04 46 59.7300 (71.7488750d)	Proper Motion RA: 0	
		Dec: +17 00 38.20 (17.01061d)	Proper Motion Dec: 0	
		Equinox: J2000	Epoch of Position: 2000	

Comments:
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
FND	All MRS	NO	FULL	Allow Auto Reorder

Dithers

#	Dither Type	Optimized For	Direction
1	2-Point	BACKGROUND	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	25	5	1	Dither 1	2	10	715.96	
1	SHORT(A)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	
2	MEDIUM(B)	MRSLONG		FASTR1	25	5	1	Dither 1	2	10	715.96	
2	MEDIUM(B)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	
3	LONG(C)	MRSLONG		FASTR1	25	5	1	Dither 1	2	10	715.96	
3	LONG(C)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	

Special Requirements	Sequence Observations 3, 4, Non-interruptible

Observation

Proposal 4876, Observation 5: DQ Tau MIRI MRS Thu Feb 06 17:00:30 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[DQ Tau background MIRI MRS (Obs 6)]

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
(1)	DQ-Tau	RA: 04 46 53.0575 (71.7210729d)	Proper Motion RA: 4.906 mas/yr	
		Dec: +17 00 0.14 (17.00004d)	Proper Motion Dec: -13.29599997461628 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[M dwarfs, Multiple stars, Pre-main sequence stars, Protoplanetary disks, T Tauri stars]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	FND	FAST	4	1	1	11.1	173498

Template

Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
All MRS	NO	FULL	Allow Auto Reorder

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	25	5	1	Dither 1	4	20	1431.921	173498
1	SHORT(A)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
2	MEDIUM(B)	MRSLONG		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
2	MEDIUM(B)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
3	LONG(C)	MRSLONG		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
3	LONG(C)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498

Special Requirements	
	Between Dates 13-FEB-2025:15:21:36 and 16-FEB-2025:15:21:36 Sequence Observations 5, 6, Non-interruptible

Observation

Proposal 4876, Observation 6: DQ Tau background MIRI MRS Thu Feb 06 17:00:30 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: [DQ Tau MIRI MRS (Obs 5)]

Diagnostics

(Visit 6:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	DQ-Tau-background	RA: 04 46 59.7300 (71.7488750d)	Proper Motion RA: 0	
		Dec: +17 00 38.20 (17.01061d)	Proper Motion Dec: 0	
		Equinox: J2000	Epoch of Position: 2000	

Comments:
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
FND	All MRS	NO	FULL	Allow Auto Reorder

Dithers

#	Dither Type	Optimized For	Direction
1	2-Point	BACKGROUND	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	25	5	1	Dither 1	2	10	715.96	
1	SHORT(A)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	
2	MEDIUM(B)	MRSLONG		FASTR1	25	5	1	Dither 1	2	10	715.96	
2	MEDIUM(B)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	
3	LONG(C)	MRSLONG		FASTR1	25	5	1	Dither 1	2	10	715.96	
3	LONG(C)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	

Special Requirements	Sequence Observations 5, 6, Non-interruptible

Observation

Proposal 4876, Observation 7: DQ Tau MIRI MRS Thu Feb 06 17:00:30 GMT 2025

Diagnostic Status: Error

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[]

Diagnostics

(DQ Tau MIRI MRS (Obs 7)) Error (Form): This target requires similar background exposures that are linked in a non-interruptible group/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)	DQ-Tau	RA: 04 46 53.0575 (71.7210729d)	Proper Motion RA: 4.906 mas/yr	
		Dec: +17 00 0.14 (17.00004d)	Proper Motion Dec: -13.29599997461628 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[M dwarfs, Multiple stars, Pre-main sequence stars, Protoplanetary disks, T Tauri stars]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	FND	FAST	4	1	1	11.1	173498

Template

Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
All MRS	NO	FULL	Allow Auto Reorder

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	25	5	1	Dither 1	4	20	1431.921	173498
1	LONG(C)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
2	MEDIUM(B)	MRSLONG		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
2	MEDIUM(B)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
3	SHORT(A)	MRSLONG		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498
3	SHORT(A)	MRSSHORT		FASTR1	25	5	1	Dither 1	4	20	1431.921	173498

Special Requirements	
	Between Dates 02-MAR-2025:10:33:36 and 04-MAR-2025:10:33:36 Sequence Observations 7, 8, Non-interruptible

Observation

Proposal 4876, Observation 8: DQ Tau background MIRI MRS Thu Feb 06 17:00:30 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Diagnostics

(Visit 8:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	DQ-Tau-background-new	RA: 04 47 0.2900 (71.7512083d) Dec: +17 00 38.20 (17.01061d) Equinox: J2000	Epoch of Position: 2000	

Comments:
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
FND	All MRS	NO	FULL	Allow Auto Reorder

Dithers

#	Dither Type	Optimized For	Direction
1	2-Point	BACKGROUND	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	25	5	1	Dither 1	2	10	715.96	
1	LONG(C)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	
2	MEDIUM(B)	MRSLONG		FASTR1	25	5	1	Dither 1	2	10	715.96	
2	MEDIUM(B)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	
3	SHORT(A)	MRSLONG		FASTR1	25	5	1	Dither 1	2	10	715.96	
3	SHORT(A)	MRSSHORT		FASTR1	25	5	1	Dither 1	2	10	715.96	

Special Requirements	Sequence Observations 7, 8, Non-interruptible