



4084 - Probing the Depths: Disequilibrium Chemistry as a Tracer of Mixing Processes in Brown Dwarf Atmospheres

Cycle: 2, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1		NIRSpec Fixed Slit Spectroscopy	(1) WISE1457+5815
	2		NIRSpec Fixed Slit Spectroscopy	(2) WISE0325+0831
	3		NIRSpec Fixed Slit Spectroscopy	(3) WISE2209-2734
	4		NIRSpec Fixed Slit Spectroscopy	(4) WISE0049+2151
	5		NIRSpec Fixed Slit Spectroscopy	(5) GL570D

ABSTRACT

Atmospheric mixing occurs in all substellar atmospheres, from free floating brown dwarfs, gas giant exoplanets, to the gas giants in our very own Solar System. This phenomenon influences the apparent chemistry in observed spectra from these objects. Changes created in the spectrum can also be utilized to measure atmospheric mixing as a function of radial depth, revealing the structure and locations convective and radiative zones within brown dwarf atmospheres. T-dwarfs are the ideal test beds for validating the state of the art models for constraining 1-D atmospheric mixing, due to their relative lack of photospheric clouds and existing ground-based near-infrared spectra. We will execute a program to observe 5 T-dwarfs with the fixed-slit F290LP/395H mode of JWST/NIRSpec for medium-resolution, 3 to 5 micron spectra to complete a sample of 7 T-dwarf with temperatures

JWST Proposal 4084 (Created: Wednesday, March 20, 2024 at 3:00:28 PM Eastern Standard Time) - Overview

between 500K - 900K and surface gravities between $\log(g)$ 3.5 - 5.5. Using detections of methane, carbon monoxide, and carbon dioxide we will construct 1-dimensional atmospheric mixing profiles for each brown dwarf and understand how the size and extent of convective zones trend with effective temperature and surface gravity. Using the SNR 100 spectra we will also detect or place upper limits on other predicted disequilibrium species like hydrogen sulfide and phosphine.

OBSERVING DESCRIPTION

We are requesting fixed-slit observations of 5 brown dwarfs to complete a sequence of 7 T-dwarfs for our science goal. We want higher resolution spectrum from the F290LP/395H mode of NIRSpec in fixed slit mode.

The targets are:

Target	J_MKO_mag	J_2MASS_mag	W2 mag	Estimated Acquisition SNR (2MASS)	Real Acquisition SNR (Data)
WISE 1457+5815	16.790	16.825	14.42	141.46	TBD
WISE 0325+0831	16.286	16.540	13.53	6.58	8
WISE 2209+2734	16.550	16.980	13.86	108.4	TBD
WISE 0049+2151	16.44	16.716	13.03	120.99	TBD
Gl570D	14.820	15.324	12.13	72.09	TBD

(update March 13, 2024, due to the low SNR on acquisition for WISE 0325 we are changing the exposure times for the other BDs)

Four of the targets are below the saturation limits for NIRSpec WATA Acquisition and the mode should be used to center the target in the slit. WISE 1457 may likely have partial saturation using the SUB2048 subarray during acquisition, but the SUB32 option produces too low of an SNR in the ETC. The models used in the ETC(notebook: 192529) are bright compared to reality at J-band so measured 2MASS J-band magnitudes were used to determine feasibility with the WATA acquisition mode.

The brown dwarfs had their exposure times chosen by how long a certain molecular feature reaches a SNR 10 per pixel, which is why exposure time does not correlate with W2 magnitude.

We followed the NIRSpec detector and dithering strategies flowchart for each target. The bright targets require the ALLSLITS subarray and NRSRAPID readout to maintain meaningful group numbers within an exposure. The fainter targets use the FULL subarray and NRSIRS2RAPID readout. The specific subarray and readout setting per target are listed below.

Target	Subarray	Readout
WISE 1457+5815	FULL	NRSIRS2RAPID
WISE 0325+0831	ALLSLITS	NRSRAPID
WISE 2209+2734	FULL	NRSIRS2RAPID
WISE 0049+2151	ALLSLITS	NRSRAPID
G1570D	ALLSLITS	NRSRAPID

Proposal 4084 - Targets - Probing the Depths: Disequilibrium Chemistry as a Tracer of Mixing Processes in Brown Dwarf Atmospheres

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	WISE1457+5815	RA: 14 57 14.7917 (224.3116321d) Dec: +58 15 9.96 (58.25277d) Equinox: J2000	Proper Motion RA: -488.5 mas/yr Proper Motion Dec: -65.8 mas/yr Parallax: .0468" Epoch of Position: 2000	
<p><i>Comments: coordinates in degrees from Best et al. 2020b taken from VizieR, RA: 224.3116319, DEC: +58.2527673 -> 14:57:14.7917, +58:15:9.96 (converted by APT got similar result in astropy conversion)</i></p> <p><i>values seen in Zhang et al 2021 are slightly off but similar, the original source was used.</i></p> <p><i>Category=Star</i> <i>Description=[Brown dwarfs]</i> <i>Extended=NO</i></p>				
(2)	WISE0325+0831	RA: 03 25 47.7691 (51.4490379d) Dec: +08 31 17.94 (8.52165d) Equinox: J2000	Proper Motion RA: 116.20 mas/yr Proper Motion Dec: -38.1 mas/yr Parallax: .07850" Epoch of Position: 2014	
<p><i>Comments: coordinates from Kirkpatrick et al. 2019 in Table 4, RA: 51.449038, DEC: 8.521650 -> 03 25 47.7691, +08 31 17.94 (converted by APT got similar result in astropy conversion)</i></p> <p><i>the Epoch is listed in header of Table 4 of Kirkpatrick+ 2019</i></p> <p><i>Category=Star</i> <i>Description=[Brown dwarfs]</i> <i>Extended=NO</i></p>				
(3)	WISE2209-2734	RA: 22 09 21.9053 (332.3412721d) Dec: -27 34 41.30 (-27.57814d) Equinox: J2000	Proper Motion RA: -781.0 mas/yr Proper Motion Dec: -430.9 mas/yr Parallax: .0782" Epoch of Position: 2014	
<p><i>Comments: coordinates from Kirkpatrick et al. 2019 in Table 4, RA: 332.341272, DEC: 27.578140 -> 22:09:21.9053, -27:34:41.30 (converted by APT got similar result in astropy conversion)</i></p> <p><i>the Epoch is listed in header of Table 4 of Kirkpatrick+ 2019</i></p> <p><i>Category=Star</i> <i>Description=[Brown dwarfs]</i> <i>Extended=NO</i></p>				
(4)	WISE0049+2151	RA: 00 49 45.5381 (12.4397421d) Dec: +21 51 19.43 (21.85540d) Equinox: J2000	Proper Motion RA: -483.20 mas/yr Proper Motion Dec: -46.50 mas/yr Parallax: .13990 " Epoch of Position: 2014	
<p><i>Comments: coordinates from Kirkpatrick et al. 2019 in Table 4, RA:12.439742, DEC: 21.855396 -> 00:49:45.5381, +21:51:19.43 (converted by APT got similar result in astropy conversion)</i></p> <p><i>the Epoch is listed in header of Table 4 of Kirkpatrick+ 2019</i></p> <p><i>Category=Star</i> <i>Description=[Brown dwarfs]</i> <i>Extended=NO</i></p>				
(5)	GL570D	RA: 14 57 14.9600 (224.3123333d) Dec: -21 21 47.80 (-21.36328d) Equinox: J2000	Proper Motion RA: 1038.08 mas/yr Proper Motion Dec: -1677.69 mas/yr Parallax: .16756" Epoch of Position: 2000	
<p><i>Comments: The coordinates, proper motion, parallax are from Table 2 in Weinberger+ 2016, the RA and DEC are consistent with 2MASS and Smart+2018. The pm_RA is consistent with Smart+ 2018, but the pm_DEC is discrepant by .01 arcsec/year. The parallax is consistent but more precise than Smart+ 2018 and includes previous measurements.</i></p> <p><i>The GAIA reference in Zhang et al. 2021 is very likely from the central host Gl 570 A cant find D in the archive. The proper motion and the parallax should apply since the objects are in the same system.</i></p> <p><i>Category=Star</i> <i>Description=[Brown dwarfs]</i> <i>Extended=NO</i></p>				

Fixed Targets

Proposal 4084 - Observation 1 - Probing the Depths: Disequilibrium Chemistry as a Tracer of Mixing Processes in Brown Dwarf Atmo...

Wed Mar 20 20:00:28 GMT 2024

Observation	Proposal 4084, Observation 1 Diagnostic Status: Warning Observing Template: NIRSspec Fixed Slit Spectroscopy										
	(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)	WISE1457+5815	RA: 14 57 14.7917 (224.3116321d) Dec: +58 15 9.96 (58.25277d) Equinox: J2000			Proper Motion RA: -488.5 mas/yr Proper Motion Dec: -65.8 mas/yr Parallax: .0468" Epoch of Position: 2000					
<i>Comments: coordinates in degrees from Best et al. 2020b taken from Vizier, RA: 224.3116319, DEC: +58.2527673 -> 14:57:14.7917, +58:15:9.96 (converted by APT got similar result in astropy conversion)</i> <i>values seen in Zhang et al 2021 are slightly off but similar, the original source was used.</i> Category=Star Description=[Brown dwarfs] Extended=NO											
Acquisition	#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	SAME	WATA	SUB2048	F110W	NRSRAPID	3	1	1	3.628	141927
Template	Slit					Subarray					
	S200A2					FULL					
Dithers	#	Primary Dither Positions					Sub-Pixel Pattern				
	1	3					NONE				
Spectral Elements	#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Ex #	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1 1	NONE	3	3	2232.1	141927

Proposal 4084 - Observation 2 - Probing the Depths: Disequilibrium Chemistry as a Tracer of Mixing Processes in Brown Dwarf Atmo...

Wed Mar 20 20:00:28 GMT 2024

Observation	Proposal 4084, Observation 2 Diagnostic Status: Warning Observing Template: NIRSspec Fixed Slit Spectroscopy										
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)	WISE0325+0831	RA: 03 25 47.7691 (51.4490379d) Dec: +08 31 17.94 (8.52165d) Equinox: J2000			Proper Motion RA: 116.20 mas/yr Proper Motion Dec: -38.1 mas/yr Parallax: .07850" Epoch of Position: 2014					
	<i>Comments: coordinates from Kirpatrick et al. 2019 in Table 4, RA: 51.449038, DEC: 8.521650 -> 03 25 47.7691, +08 31 17.94 (converted by APT got similar result in astropy conversion)</i> <i>the Epoch is listed in header of Table 4 of Kirkpatrick+ 2019</i> Category=Star Description=[Brown dwarfs] Extended=NO										
Acquisition	#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	SAME	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	141927
Template	Slit					Subarray					
	S200A2					ALLSLITS					
Dithers	#	Primary Dither Positions					Sub-Pixel Pattern				
	1	3					NONE				
Spectral Elements	#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp #	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	G395H/F290LP	S200A2	NRSRAPID	45	1 1	NONE	3	3	758.233	141927

Proposal 4084 - Observation 3 - Probing the Depths: Disequilibrium Chemistry as a Tracer of Mixing Processes in Brown Dwarf Atmo...

Wed Mar 20 20:00:28 GMT 2024

Observation	Proposal 4084, Observation 3 Diagnostic Status: Warning Observing Template: NIRSpec Fixed Slit Spectroscopy										
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		
	(3)	WISE2209-2734	RA: 22 09 21.9053 (332.3412721d) Dec: -27 34 41.30 (-27.57814d) Equinox: J2000			Proper Motion RA: -781.0 mas/yr Proper Motion Dec: -430.9 mas/yr Parallax: .0782" Epoch of Position: 2014					
	<i>Comments: coordinates from Kirkpatrick et al. 2019 in Table 4, RA: 332.341272, DEC: 27.578140 -> 22:09:21.9053, -27:34:41.30 (converted by APT got similar result in astropy conversion)</i> <i>the Epoch is listed in header of Table 4 of Kirkpatrick+ 2019</i> Category=Star Description=[Brown dwarfs] Extended=NO										
Acquisition	#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	SAME	WATA	SUB2048	F110W	NRSRAPID	3	1	1	3.628	141927
Template	Slit					Subarray					
	S200A2					FULL					
Dithers	#	Primary Dither Positions					Sub-Pixel Pattern				
	1	3					NONE				
Spectral Elements	#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Ex #	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1 1	NONE	3	3	2232.1	141927

Proposal 4084 - Observation 4 - Probing the Depths: Disequilibrium Chemistry as a Tracer of Mixing Processes in Brown Dwarf Atmo...

Wed Mar 20 20:00:28 GMT 2024

Observation	Proposal 4084, Observation 4 Diagnostic Status: Warning Observing Template: NIRSspec Fixed Slit Spectroscopy										
	(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)	WISE0049+2151	RA: 00 49 45.5381 (12.4397421d) Dec: +21 51 19.43 (21.85540d) Equinox: J2000			Proper Motion RA: -483.20 mas/yr Proper Motion Dec: -46.50 mas/yr Parallax: .13990 " Epoch of Position: 2014					
<i>Comments: coordinates from Kirkpatrick et al. 2019 in Table 4, RA:12.439742, DEC: 21.855396 -> 00:49:45.5381, +21:51:19.43 (converted by APT got similar result in astropy conversion)</i> <i>the Epoch is listed in header of Table 4 of Kirkpatrick+ 2019</i> Category=Star Description=[Brown dwarfs] Extended=NO											
Acquisition	#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	SAME	WATA	SUB2048	F110W	NRSRAPID	3	1	1	3.628	141927
Template	Slit					Subarray					
	S200A2					ALLSLITS					
Dithers	#	Primary Dither Positions					Sub-Pixel Pattern				
	1	3					NONE				
Spectral Elements	#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Ex #	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	G395H/F290LP	S200A2	NRSRAPID	75	1	1	NONE	3	3	1252.693

Proposal 4084 - Observation 5 - Probing the Depths: Disequilibrium Chemistry as a Tracer of Mixing Processes in Brown Dwarf Atmo...

Wed Mar 20 20:00:28 GMT 2024

Observation	Proposal 4084, Observation 5 Diagnostic Status: Warning Observing Template: NIRSpec Fixed Slit Spectroscopy										
	(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.										
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous		
	(5)	GL570D	RA: 14 57 14.9600 (224.3123333d) Dec: -21 21 47.80 (-21.36328d) Equinox: J2000			Proper Motion RA: 1038.08 mas/yr Proper Motion Dec: -1677.69 mas/yr Parallax: .16756" Epoch of Position: 2000					
<i>Comments: The coordinates, proper motion, parallax are from Table 2 in Weinberger+ 2016, the RA and DEC are consistent with 2MASS and Smart+2018. The pm_RA is consistent with Smart+ 2018, but the pm_DEC is discrepant by .01 arcsec/year. The parallax is consistent but more precise than Smart+ 2018 and includes previous measurements.</i> <i>The GAIA reference in Zhang et al. 2021 is very likely from the central host Gl 570 A cant find D in the archive. The proper motion and the parallax should apply since the objects are in the same system.</i> Category=Star Description=[Brown dwarfs] Extended=NO											
Acquisition	#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	SAME	WATA	SUB32	F110W	NRSRAPIDD6	3	1	1	0.26	146337
Template	Slit					Subarray					
	S200A2					ALLSLITS					
Dithers	#	Primary Dither Positions					Sub-Pixel Pattern				
	1	3					NONE				
Spectral Elements	#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Ex #	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	G395H/F290LP	S200A2	NRSRAPID	20	1	1	NONE	3	3	346.183