



6474 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Cycle: 3, Proposal Category: GO

INVESTIGATORS

<i>Name</i>	<i>Institution</i>
Dr. John Sebastian Pineda (PI)	University of Colorado at Boulder
Dr. Melodie Kao (CoI)	Lowell Observatory
Dr. Joachim Saur (CoI) (ESA Member)	Universitat zu Koeln
Prof. Kevin France (CoI)	University of Colorado at Boulder
Dr. Jake Turner (CoI)	Cornell University
Dr. Johanna Vos (CoI) (ESA Member)	University of Dublin, Trinity College
Dr. Ben Burningham (CoI) (ESA Member)	University of Hertfordshire
Dr. Caroline Morley (CoI)	University of Texas at Austin
Prof. Stuart Littlefair (CoI) (ESA Member)	University of Sheffield
Prof. Gregg Hallinan (CoI)	California Institute of Technology
Dr. Jacqueline Kelly Faherty (CoI)	American Museum of Natural History

OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
J1237				
	1	J1237_NIR	NIRSpec Bright Object Time Series	(1) 2MASS-J12373919+6526148
	5	J1237_MIR	MIRI Low Resolution Spectroscopy	(1) 2MASS-J12373919+6526148
J1047				
	2	J1047_NIR	NIRSpec Bright Object Time Series	(2) 2MASSW-J1047539+212423
	4	J1047_MIR	MIRI Low Resolution Spectroscopy	(2) 2MASSW-J1047539+212423
W1122				

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
	3	W1122_NIR	NIRSpec Bright Object Time Series	(3) 2MASS-J11225550+2550250
	6	W1122_MIR	MIRI Low Resolution Spectroscopy	(3) 2MASS-J11225550+2550250

ABSTRACT

Aurorae at radio wavelengths indicate that stable large-scale magnetospheric currents can drive persistent energetic electron beams into brown dwarf atmospheres. On Jupiter, these electrical currents produce UV emissions from molecular hydrogen, infrared thermal emission, and H₃⁺ emission through collisional ionization and subsequent ion chemistry. However, emerging evidence points to multiwavelength auroral behaviors on brown dwarfs that differ from Jupiter. Most of the auroral energy deposited in these cool dwarfs dramatically heat upper atmospheric layers and should emerge as thermal emission. New evidence from JWST demonstrates key evidence for such thermal atmospheric inversions. We propose to characterize this thermal structure for 3 auroral T-dwarfs expected to exhibit similar aurorally impacted surface regions. Through spectrophotometric monitoring with JWST across 3-10 microns and joint radio observations of the targets' radio aurorae, we aim to measure (1) the total auroral power of these systems, (2) the efficiency of radio aurorae, and (3) compare the multi-wavelength atmospheric impact across a range of auroral properties. This study measures significant unknowns in the field of brown dwarf aurorae: the total auroral power and multi-wavelength energy partitions.

OBSERVING DESCRIPTION

This proposed program will observe 3 cool T-dwarf targets with spectrophotometric monitoring using NIRSpec G395H, and MIRI LRS. The spectrophotometric monitoring will assess variability at 3-5 um and across 5-13 microns to measure the influence of auroral energy deposition in the atmosphere over a full rotational period (<2.5 hr)

The impact will be evident through emission features in methane and ammonia, and imply the presence of inverted atmospheric temperature profiles. This program will use the data to infer and model the thermal structure of the atmosphere, and the amount of energy required to produce it. The rotationally variable spectra will be used to further define the surface extent of the auroral regions in order to measure the total power impacting the cool dwarf atmospheres.

The proposal would also monitor each target with the JVL A at X-band (8-12 GHz) to measure the radio luminosities of the auroral emissions with which to compare against the JWST results from thermal emissions in the IR.

The program proposes to further compare these effects across the sample with differing auroral properties.

Proposal 6474 - Targets - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	2MASS-J12373919+6526148	RA: 12 37 36.5490 (189.4022875d) Dec: +65 26 5.57 (65.43488d) Equinox: J2000	Proper Motion RA: -1026.6 mas/yr Proper Motion Dec: -567.5 mas/yr Parallax: 0.09607" Epoch of Position: 2015.4	
<p><i>Comments: Coordinates updated from the CatWISE2020 catalogue: CWISE J123736.29+652604.7</i></p> <p><i>CatWISE catalogue entries: pmra = -1026.6 +- 7.6 pmdec = -567.5 +- 7.7 mas/yr</i> <i>Coordinates uncertainties at specified epoch are <0.04 arcsecs</i></p> <p><i>WISE astrometry baseline includes most recent data to an average epoch of 57713.421534 MJD. Catalogue coordinates use PM to compute ICRS coordinates at epoch of 2015.4</i> <i>Category=Star</i> <i>Description=[Brown dwarfs, T dwarfs]</i> <i>Extended=NO</i></p>				
(2)	2MASSW-J1047539+212423	RA: 10 47 51.7874 (161.9657808d) Dec: +21 24 14.92 (21.40414d) Equinox: J2000	Proper Motion RA: -1684.4 mas/yr Proper Motion Dec: -495.9 mas/yr Parallax: 0.0947300000000001" Epoch of Position: 2015.4	
<p><i>Comments: Coordinates updated from the CatWISE2020 catalogue: CWISE J104751.75+212414.7</i></p> <p><i>CatWISE catalogue entries: pmra = -1684.4 +- 6.8 pmdec = -495.9 +- 7.7 mas/yr</i> <i>Coordinate uncertainties are <0.03 arcsecs</i></p> <p><i>WISE astrometry baseline includes most recent data to an average epoch of 57273.057542 MJD. Catalogue coordinates use PM to compute ICRS coordinates at epoch of 2015.4</i> <i>Category=Star</i> <i>Description=[Brown dwarfs, T dwarfs]</i> <i>Extended=NO</i></p>				
(3)	2MASS-J11225550+2550250	RA: 11 22 54.3459 (170.7264412d) Dec: +25 50 20.33 (25.83898d) Equinox: J2000	Proper Motion RA: -1023.8 mas/yr Proper Motion Dec: -349.3 mas/yr Parallax: 0.0629" Epoch of Position: 2015.4	
<p><i>Comments: Coordinates updated from the CatWISE2020 catalogue: CWISE J112254.33+255020.2</i></p> <p><i>CatWISE catalogue entries: pmra = -1023.8 +- 14.8 pmdec = -349.3 +- 15.5 mas/yr</i> <i>Coordinate uncertainties are <0.06 arcsecs</i></p> <p><i>WISE astrometry baseline includes most recent data to an average epoch of 57237.962424 MJD. Catalogue coordinates use PM to compute ICRS coordinates at epoch of 2015.4</i> <i>Category=Star</i> <i>Description=[Brown dwarfs, T dwarfs]</i> <i>Extended=NO</i></p>				

Fixed Targets

Proposal 6474 - Observation 1 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Mon Dec 23 19:00:10 GMT 2024

Observation	<p>Proposal 6474, Observation 1: J1237_NIR</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec Bright Object Time Series</p>																																								
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Proposal 6474 - Observation 1 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Special Requirements

Time Series Observation
No Parallel Attachments

Group Observations 1, 5 within 60 Days

Proposal 6474 - Observation 5 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Mon Dec 23 19:00:10 GMT 2024

Observation	Proposal 6474, Observation 5: J1237_MIR Diagnostic Status: Warning Observing Template: MIRI Low Resolution Spectroscopy <i>Comments: Potential high gain antenna move is acceptable for monitoring observation</i>																												
	(J1237_MIR (Obs 5)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure. (Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.																												
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Template	Subarray				Obtain Verification Image?																								
	SLITLESSPRISM				true																								
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Proposal 6474 - Observation 5 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Spectral Elements	#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
		1	FASTR1	1032	66	66	1	1	10842.87
Special Requirements	Aperture PA Range 134.83544897 to 154.83544897 Degrees (V3 130.0 to 150.0) Aperture PA Range 184.83544897 to 214.83544897 Degrees (V3 180.0 to 210.0) Aperture PA Range 349.83544897 to 54.83544897 Degrees (V3 345.0 to 50.0) Time Series Observation No Parallel Attachments Group Observations 1, 5 within 60 Days								

Proposal 6474 - Observation 2 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Mon Dec 23 19:00:10 GMT 2024

Observation	<p>Proposal 6474, Observation 2: J1047_NIR</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec Bright Object Time Series</p>																															
Diagnostics	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.																															
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Proposal 6474 - Observation 2 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Special Requirements

Time Series Observation
No Parallel Attachments

Group Observations 2, 4 within 60 Days

Proposal 6474 - Observation 4 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Mon Dec 23 19:00:10 GMT 2024

Observation	Proposal 6474, Observation 4: J1047_MIR Diagnostic Status: Warning Observing Template: MIRI Low Resolution 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			
	(2)	2MASSW-J1047539+212423	RA: 10 47 51.7874 (161.9657808d) Dec: +21 24 14.92 (21.40414d) Equinox: J2000	Proper Motion RA: -1684.4 mas/yr Proper Motion Dec: -495.9 mas/yr Parallax: 0.0947300000000001" Epoch of Position: 2015.4						
<i>Comments: Coordinates updated from the CatWISE2020 catalogue: CWISE J104751.75+212414.7</i> <i>CatWISE catalogue entries: pmra = -1684.4 +- 6.8 pmdec = -495.9 +- 7.7 mas/yr</i> <i>Coordinate uncertainties are <0.03 arcsecs</i> <i>WISE astrometry baseline includes most recent data to an average epoch of 57273.057542 MJD. Catalogue coordinates use PM to compute ICRS coordinates at epoch of 2015.4</i> <i>Category=Star</i> <i>Description=[Brown dwarfs, T dwarfs]</i> <i>Extended=NO</i>										
Acquisition	#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1	2 2MASSW-J1047539+212423	F1000W	FAST	8	1	1	1.272	178527.13	
Template	Subarray				Obtain Verification Image?					
	SLITLESSPRISM				true					
Dithers	#	Dither Type	No. Spectral Steps	Spectral Step Offset	No. Spatial Steps	Spatial Step Offset				
	1	NONE								
Pointing Verification	#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter
	1	FASTR1	8	1	1	1	1	1.272		F1000W

Proposal 6474 - Observation 4 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Spectral Elements	#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	FASTR1	802	69	69	1	1	8811.77	178527.17
Special Requirements	Time Series Observation No Parallel Attachments								
	Group Observations 2, 4 within 60 Days								

Proposal 6474 - Observation 3 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Mon Dec 23 19:00:10 GMT 2024

Observation	<p>Proposal 6474, Observation 3: W1122_NIR</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec Bright Object Time Series</p>																																							
Diagnostics	(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.																																							
Fixed Targets	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Target Coordinates</th> <th colspan="3">Targ. Coord. Corrections</th> <th colspan="4">Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(3)</td> <td>2MASS-J11225550+2550250</td> <td>RA: 11 22 54.3459 (170.7264412d) Dec: +25 50 20.33 (25.83898d) Equinox: J2000</td> <td>Proper Motion RA: -1023.8 mas/yr</td> <td>Proper Motion Dec: -349.3 mas/yr</td> <td>Parallax: 0.0629"</td> <td colspan="4">Epoch of Position: 2015.4</td> </tr> <tr> <td colspan="10"> <p><i>Comments: Coordinates updated from the CatWISE2020 catalogue: CWISE J112254.33+255020.2</i></p> <p><i>CatWISE catalogue entries: pmra = -1023.8 +- 14.8 pmdec = -349.3 +- 15.5 mas/yr</i></p> <p><i>Coordinate uncertainties are <0.06 arcsecs</i></p> <p><i>WISE astrometry baseline includes most recent data to an average epoch of 57237.962424 MJD. Catalogue coordinates use PM to compute ICRS coordinates at epoch of 2015.4</i></p> <p><i>Category=Star</i></p> <p><i>Description=[Brown dwarfs, T dwarfs]</i></p> <p><i>Extended=NO</i></p> </td> </tr> </tbody> </table>										#	Name	Target Coordinates	Targ. Coord. Corrections			Miscellaneous				(3)	2MASS-J11225550+2550250	RA: 11 22 54.3459 (170.7264412d) Dec: +25 50 20.33 (25.83898d) Equinox: J2000	Proper Motion RA: -1023.8 mas/yr	Proper Motion Dec: -349.3 mas/yr	Parallax: 0.0629"	Epoch of Position: 2015.4				<p><i>Comments: Coordinates updated from the CatWISE2020 catalogue: CWISE J112254.33+255020.2</i></p> <p><i>CatWISE catalogue entries: pmra = -1023.8 +- 14.8 pmdec = -349.3 +- 15.5 mas/yr</i></p> <p><i>Coordinate uncertainties are <0.06 arcsecs</i></p> <p><i>WISE astrometry baseline includes most recent data to an average epoch of 57237.962424 MJD. Catalogue coordinates use PM to compute ICRS coordinates at epoch of 2015.4</i></p> <p><i>Category=Star</i></p> <p><i>Description=[Brown dwarfs, T dwarfs]</i></p> <p><i>Extended=NO</i></p>									
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Template	<p>Subarray</p> <p>SUB2048</p>																																							
Spectral Elements	<table border="1"> <thead> <tr> <th>#</th> <th>Grating/Filter</th> <th>Readout Pattern</th> <th>Groups/Int</th> <th>Integrations/Exp</th> <th>Exposures/Dith</th> <th>Total Dithers</th> <th>Total Integrations</th> <th>Total Exposure Time</th> <th>ETC Wkbk.Calc ID</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>G395H/F290LP</td> <td>NRSRAPID</td> <td>152</td> <td>55</td> <td>1</td> <td>1</td> <td>55</td> <td>7591.456</td> <td>178527.12</td> </tr> </tbody> </table>										#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	1	G395H/F290LP	NRSRAPID	152	55	1	1	55	7591.456	178527.12										
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Proposal 6474 - Observation 3 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Special Requirements

Time Series Observation
No Parallel Attachments

Group Observations 3, 6 within 60 Days

Proposal 6474 - Observation 6 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Mon Dec 23 19:00:10 GMT 2024

Observation	<p>Proposal 6474, Observation 6: W1122_MIR</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: MIRI Low Resolution Spectroscopy</p>																										
	<p>(Visit 6:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p>																										
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	#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID																		
1	3 2MASS-J11225550+2550250	F1000W	FAST	22	1	1	3.499	178527.22																			
Template	Subarray				Obtain Verification Image?																						
	SLITLESSPRISM				true																						
Dithers	#	Dither Type	No. Spectral Steps	Spectral Step Offset	No. Spatial Steps	Spatial Step Offset																					
	1	NONE																									
Pointing Verification	#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter																	
	1	FASTR1	22	1	1	1	1	3.499		F1000W																	

Proposal 6474 - Observation 6 - T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Spectral Elements	#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	FASTR1	880	67	67	1	1	9387.495	178527.25
Special Requirements	Time Series Observation No Parallel Attachments Group Observations 3, 6 within 60 Days								