



11133 - Identical or Fraternal Twins? The First Rigorous Test of Chemical Tagging in the T/Y Transition with Benchmark Brown Dwarf Binaries

Cycle: 5, Proposal Category: GO

INVESTIGATORS

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Dr. Zhoujian Zhang (PI)	University of Rochester
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Jonas Sauter (CoI) (ESA Member)	Max Planck Institute for Astronomy
Melanie J. Rowland (CoI)	American Museum of Natural History

OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	MRS WISE1217	MIRI Medium Resolution Spectroscopy	(2) WISE-J121756.90+162640.8
	2	MRS WISE1711	MIRI Medium Resolution Spectroscopy	(3) WISE-J171104.60+350036.8
	3	MRS WISE0226	MIRI Medium Resolution Spectroscopy	(4) WISE-J022623.98-021142.8
	4	NIRSpec WISE1217	NIRSpec IFU Spectroscopy	(2) WISE-J121756.90+162640.8
	5	NIRSpec WISE1711	NIRSpec IFU Spectroscopy	(3) WISE-J171104.60+350036.8
	6	NIRSpec WISE0226	NIRSpec IFU Spectroscopy	(4) WISE-J022623.98-021142.8

ABSTRACT

JWST has revolutionized the study of brown dwarfs and exoplanets by providing direct access to the coldest atmospheric regime at the T/Y transition, enabling precise and simultaneous measurements of [M/H], C/O, N/O, and even isotopic abundance ratio, $^{14}\text{N}/^{15}\text{N}$. These advances open a new frontier: extending chemical tagging --- the use of atmospheric compositions as fingerprints of formation pathways --- into the T/Y regime to

trace the origins of the coldest exo-worlds. While the central assumption of chemical tagging --- that coeval objects formed through star-like processes share nearly identical compositions --- has been rigorously validated in the stellar regime, it has never been examined in the T/Y regime. We propose the first rigorous test of chemical tagging at the T/Y transition by obtaining spatially resolved NIRSpec/G395H and MIRI/MRS spectra of benchmark brown dwarf binaries with clear star-like origins. By measuring [M/H], C/O, N/O, and $^{14}\text{N}/^{15}\text{N}$ for individual binary components, we will establish the first empirical baseline of intrinsic compositional scatter among coeval T/Y exo-worlds. These results will reveal whether brown dwarfs form from chemically homogeneous molecular clouds as stars do and identify which abundance tracers are the most reliable indicators of formation pathways. Our program will also provide crucial context for interpreting the compositions of the coldest directly imaged exoplanets and anchor both existing and future atmospheric studies of cold exo-worlds in the JWST and ELT era.

OBSERVING DESCRIPTION

We will observe three brown dwarf binaries, in each case using both NIRSPEC/G395H and MIRI/MRS IFU. IFU is essential to spatially resolve the binary components for each of our observations. All three brown dwarfs are sufficiently widely separated ($>0.55''$) that the spectra of individual components can be resolved across 3--14 μm , but close enough to be within the field of view for a single telescope pointing.

For NIRSPEC/G395H, our target acquisition will use the WATA mode, the SUB2048 subarray, and the NRSRAPID readout pattern. Our spectroscopic observations will use the IFU mode over the FIXEDSLIT mode. We request the $S/N > 30$ across 4.2--4.8 μm to enable robust detections of CO and CO₂ molecules.

MIRI/MRS is an IFU. Our target acquisition will use the F1000W filter and FAST readout pattern. For spectroscopic observations, we will use all three dispersers (A/B/C), which is essential for detecting $^{15}\text{NH}_3$ features that span 2C, 3A, and 3B. Our time request is calculated based on our retrieval analyses of simulated MRS spectra and will yield $>5\sigma$ detection for $^{14}\text{N}/^{15}\text{N}$ ratios for all our targets across a broad range of possible isotopic ratios.

For both NIRSPEC/G395H and MIRI/MRS, we will use four dither positions to achieve better sampling of the PSF and will use the dithered science data themselves to subtract the background (since the brown dwarfs are faint, and their PSFs consequently have a small footprint on the detector). We will use target acquisition to place the brown dwarfs precisely at calibrated positions on the detector (all our targets are bright enough to allow sufficient SNR to carry out target acquisition).

Proposal 11133 - Targets - Identical or Fraternal Twins? The First Rigorous Test of Chemical Tagging in the T/Y Transition with Bench...

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	WISE-J121756.90+162640.8	RA: 12 17 56.3545 (184.4848104d) Dec: +16 26 53.70 (16.44825d) Equinox: J2000	Proper Motion RA: 754.9 mas/yr Proper Motion Dec: -1249.799999914103 mas/yr Parallax: 0.1074000000000001" Epoch of Position: 2000	
<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.</i></p> <p><i>Category=Star</i> <i>Description=[Brown dwarfs, T dwarfs, Y dwarfs]</i></p>				
(3)	WISE-J171104.60+350036.8	RA: 17 11 4.7280 (257.7697000d) Dec: +35 00 37.63 (35.01045d) Equinox: J2000	Proper Motion RA: -157.6 mas/yr Proper Motion Dec: -76.30000004610338 mas/yr Parallax: 0.0433" Epoch of Position: 2000	
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(4)	WISE-J022623.98-021142.8	RA: 02 26 24.2033 (36.6008471d) Dec: -02 11 37.66 (-2.19379d) Equinox: J2000	Proper Motion RA: -294.4 mas/yr Proper Motion Dec: -432.3000000340471 mas/yr Parallax: 0.05629999999999996" Epoch of Position: 2000	
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Fixed Targets

Proposal 11133 - Observation 1 - Identical or Fraternal Twins? The First Rigorous Test of Chemical Tagging in the T/Y Transition with ...

Fri Mar 13 21:01:56 GMT 2026

Observation	Proposal 11133, Observation 1: MRS WISE1217 Diagnostic Status: Warning Observing Template: MIRI Medium Resolution Spectroscopy																																																																																																						
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Proposal 11133 - Observation 2 - Identical or Fraternal Twins? The First Rigorous Test of Chemical Tagging in the T/Y Transition with ...

Fri Mar 13 21:01:56 GMT 2026

Observation	Proposal 11133, Observation 2: MRS WISE1711 Diagnostic Status: Warning Observing Template: MIRI Medium Resolution Spectroscopy												
	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.												
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous				
	(3)	WISE-J171104.60+350036.8	RA: 17 11 4.7280 (257.7697000d)	Dec: +35 00 37.63 (35.01045d)	Equinox: J2000	Proper Motion RA: -157.6 mas/yr	Proper Motion Dec: -76.30000004610338 mas/yr	Parallax: 0.0433"	Epoch of Position: 2000				
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM. Category=Star Description=[Brown dwarfs, T dwarfs, Y dwarfs]													
Acquisition	#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID				
	1	SAME	F1000W	FAST	10	1	1	27.75	272615.22				
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/E xp	Exposures/Dit h	Dither	Total Dithers	Total Integrations	Total Exposure Time	Optional ETC ID
	1	SHORT(A)	MRSLONG		SLOWR1	30	4	1	Dither 1	4	16	11753.841	
	1	SHORT(A)	MRSSHORT		SLOWR1	30	4	1	Dither 1	4	16	11753.841	
	2	MEDIUM(B)	MRSLONG		SLOWR1	30	4	1	Dither 1	4	16	11753.841	
	2	MEDIUM(B)	MRSSHORT		SLOWR1	30	4	1	Dither 1	4	16	11753.841	272615.32
	3	LONG(C)	MRSLONG		SLOWR1	30	4	1	Dither 1	4	16	11753.841	
	3	LONG(C)	MRSSHORT		SLOWR1	30	4	1	Dither 1	4	16	11753.841	

Proposal 11133 - Observation 3 - Identical or Fraternal Twins? The First Rigorous Test of Chemical Tagging in the T/Y Transition with ...

Fri Mar 13 21:01:56 GMT 2026

Observation	Proposal 11133, Observation 3: MRS WISE0226 Diagnostic Status: Warning Observing Template: MIRI Medium Resolution Spectroscopy																									
	(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>Targ. Coord. Corrections</th> <th>Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(4)</td> <td>WISE-J022623.98-021142.8</td> <td>RA: 02 26 24.2033 (36.6008471d) Dec: -02 11 37.66 (-2.19379d) Equinox: J2000</td> <td>Proper Motion RA: -294.4 mas/yr Proper Motion Dec: -432.300000340471 mas/yr Parallax: 0.05629999999999996" Epoch of Position: 2000</td> <td></td> </tr> </tbody> </table>	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous	(4)	WISE-J022623.98-021142.8	RA: 02 26 24.2033 (36.6008471d) Dec: -02 11 37.66 (-2.19379d) Equinox: J2000	Proper Motion RA: -294.4 mas/yr Proper Motion Dec: -432.300000340471 mas/yr Parallax: 0.05629999999999996" Epoch of Position: 2000		Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM. Category=Star Description=[Brown dwarfs, T dwarfs, Y dwarfs]														
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#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID																		
1	SAME	F1000W	FAST	10	1	1	27.75	272615.18																		
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	1	SHORT(A)	MRSLONG		SLOWR1	30	5	1	Dither 1	4	20	14716.191														
	1	SHORT(A)	MRSSHORT		SLOWR1	30	5	1	Dither 1	4	20	14716.191														
	2	MEDIUM(B)	MRSLONG		SLOWR1	30	5	1	Dither 1	4	20	14716.191														
	2	MEDIUM(B)	MRSSHORT		SLOWR1	30	5	1	Dither 1	4	20	14716.191	272615.28													
	3	LONG(C)	MRSLONG		SLOWR1	30	5	1	Dither 1	4	20	14716.191														
	3	LONG(C)	MRSSHORT		SLOWR1	30	5	1	Dither 1	4	20	14716.191														

Proposal 11133 - Observation 4 - Identical or Fraternal Twins? The First Rigorous Test of Chemical Tagging in the T/Y Transition with ...

Fri Mar 13 21:01:56 GMT 2026

Observation	Proposal 11133, Observation 4: NIRSpec WISE1217 Diagnostic Status: Warning Observing Template: NIRSpec IFU Spectroscopy											
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)	WISE-J121756.90+162640.8	RA: 12 17 56.3545 (184.4848104d) Dec: +16 26 53.70 (16.44825d) Equinox: J2000			Proper Motion RA: 754.9 mas/yr Proper Motion Dec: -1249.799999914103 mas/yr Parallax: 0.10740000000000001" Epoch of Position: 2000						
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Acquisition	#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID	
	1	2 WISE-J121756.90+162640.8	WATA	SUB2048	F140X	NRSRAPID	3	1	1	3.628	272615.21	
Template	HFF Readout Mode											
	false											
Dithers	#	Dither Type		Size	Starting Point			Number of Points	Points			
	1	4-POINT-DITHER										
Spectral Elements	#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	Optional ETC ID
	1	G395H/F290LP	NRSIRS2RAPID	35	1	false	true	NONE	4	4	2100.8	272615.37

Proposal 11133 - Observation 5 - Identical or Fraternal Twins? The First Rigorous Test of Chemical Tagging in the T/Y Transition with ...

Fri Mar 13 21:01:56 GMT 2026

Observation	<p>Proposal 11133, Observation 5: NIRSpec WISE1711</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec IFU Spectroscopy</p>																																		
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Proposal 11133 - Observation 6 - Identical or Fraternal Twins? The First Rigorous Test of Chemical Tagging in the T/Y Transition with ...

Fri Mar 13 21:01:56 GMT 2026

Observation	<p>Proposal 11133, Observation 6: NIRSpec WISE0226</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec IFU Spectroscopy</p>											
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			
	(4)	WISE-J022623.98-021142.8	RA: 02 26 24.2033 (36.6008471d) Dec: -02 11 37.66 (-2.19379d) Equinox: J2000			Proper Motion RA: -294.4 mas/yr Proper Motion Dec: -432.300000340471 mas/yr Parallax: 0.05629999999999996" Epoch of Position: 2000						
	<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.</i></p> <p><i>Category=Star</i></p> <p><i>Description= Brown dwarfs, T dwarfs, Y dwarfs </i></p>											
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	1	4 WISE-J022623.98-021142.8	WATA	SUB2048	CLEAR	NRSRAPID	3	1	1	3.628	272615.19	
Template	<p>HFF Readout Mode</p> <p>false</p>											
Dithers	#	Dither Type		Size	Starting Point			Number of Points		Points		
	1	4-POINT-DITHER										
Spectral Elements	#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	Optional ETC ID
	1	G395H/F290LP	NRSIRS2	14	2	false	true	NONE	4	8	8286.49	272615.35