



# 2104 - Mapping the hot gas where an outflow is launched from a protoplanetary disk

Cycle: 1, 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>
Mapping of ro-vibrational molecular lines and atomic lines				
	1	Ro-vibrational line of CO	NIRSpec IFU Spectroscopy	(1) IRAS-04365+2535

## ABSTRACT

The most prominent manifestation of early star formation is energetic feedback in the form of a protostellar jet and/or wind, emanating from the disk and the central few au near the new star. Outflows remove the angular momentum from infalling disk material and assist the accretion process through the disk. Although there have been many theoretical and numerical studies on outflow launching, it has proven very challenging to

observationally measure the physical conditions at the base of the outflow. In particular, the proposed mechanisms predict high gas temperatures ( $> 1000$  K) in the vicinity of the launching region. Meanwhile, the Atacama Large Millimeter/submillimeter Array has successfully observed the launching of the cooler molecular outflows down to au scales in protoplanetary disks. One such a well-studied object is the Class I protostar TMC1A. This proposal aims to spatially map the hot atomic and molecular gas towards the TMC1A protostar and disk using JWST in order to understand the physical conditions of the launching region. In this program, we will target the ro-vibrational lines of CO, HCN, H<sub>2</sub>O, and H<sub>2</sub>, as well as a set of atomic H lines and one [Fe II] line, that will permit us to examine the accretion and high-temperature jet, respectively. Previous observations have detected (but not spatially resolved) some of the hot molecular lines towards TMC1A, ensuring the feasibility of this program. With the spatial information, sensitivity, and wavelength coverage of NIRSPEC IFU on JWST, these observations will significantly advance our understanding of the physical conditions in the outflow launching region of young protostellar systems.

### **OBSERVING DESCRIPTION**

We propose to study the physical conditions at the base of the outflow launching region. This observation uses the NIRSPEC IFU to cover various molecular and atomic lines from 1 to 5 microns at the highest spectral resolution. The spectral resolution is 2700 at G140H, G235H, and G395G gratings. The TMC1A dis, the base of its outflow, and its immediate surrounds fit within the NIRSPEC IFU field of view and thus a single pointing centered on the protostar is sufficient.

The main target is the low-mass young stellar object TMC1A. It is a bright source at 4.8 microns but heavily extincted such that it is very dim at 1 micron. The NRSRAPID readout patten is chosen for both 235H and G395H gratings to ensure the detector is not saturated. Within less than 1 hour, the S/N is easily above 500. With the sensitivity provided by JWST NIRSPEC, we will be able to search for faint atomic and molecular lines that were not detected with other facilities. Furthermore, we will be able to spatially resolve the emission lines.

We will use CYCLING DITHER to mitigate the leakage from the MSA. There is a sufficient blank sky in the coverage of the IFU to perform sky and background subtraction.

Proposal 2104 - Targets - Mapping the hot gas where an outflow is launched from a protoplanetary disk

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	IRAS-04365+2535	RA: 04 39 35.1936 (69.8966400d) Dec: +25 41 44.73 (25.69576d) Equinox: J2000	Proper Motion RA: 0 mas/yr Proper Motion Dec: 0 mas/yr Epoch of Position: 2000	
	<i>Comments: This object was generated by the target selector and retrieved from the SIMBAD database. The center is slightly offset from ALMA observations. The target is most likely not extended in most wavelength but it can be extended in the regimes correspond to a few emission tracers. Therefore, we opt to state that the source is extended.</i> Category=ISM Description=[Interstellar dust, Interstellar molecules, Molecular gas, Pre-main sequence stars, Protostars] Extended=YES				

Proposal 2104 - Observation 1 - Mapping the hot gas where an outflow is launched from a protoplanetary disk

Wed Mar 31 04:06:49 GMT 2021

<b>Observation</b>	<p><b>Proposal 2104, Observation 1: Ro-vibrational line of CO</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRSpec IFU Spectroscopy</p>											
<b>Diagnostics</b>	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>			
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<b>Acquisition</b>	<b>#</b>	<b>Target</b>	<b>TA Method</b>	<b>Subarray</b>	<b>Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>	
	1	SAME	WATA	FULL	F110W	NRSRAPID	3	1	1	42.947	52138.4	
<b>Dithers</b>	<b>#</b>	<b>Dither Type</b>			<b>Size</b>	<b>Starting Point</b>		<b>Number of Points</b>	<b>Points</b>			
	1	CYCLING			MEDIUM	6		6	6			
<b>Spectral Elements</b>	<b>#</b>	<b>Grating/Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Leakcal</b>	<b>Dither</b>	<b>Autocal</b>	<b>Total Dithers</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	G395H/F290LP	NRSRAPID	4	4	false	true	NONE	6	24	1288.412	52138.1
	2	G235H/F170LP	NRSRAPID	15	2	false	true	NONE	6	12	2061.46	52138.2
	3	G140H/F100LP	NRSRAPID	60	2	false	true	NONE	6	12	7859.316	52138.3
<b>Special Requirements</b>	No Parallel											