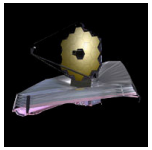

3222 - Cask-strength clouds: high percentage of methanol and HDO ices

Cycle: 2, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
NIRCAM pre-imaging				
	1	IRAS16293-nircam-pre-imaging	NIRCam Imaging	(2) IRAS16293-NIRCAM
NIRSpec MOS				
	2	6Feb2024-1pntg-16-32-29.1343--24-28-39.944	NIRSpec MultiObject Spectroscopy	(3) IRAS16293_MSA_Cat_6Feb2024

ABSTRACT

Understanding the chemical inventory from clouds to planets is a major task in astrochemistry. Low-mass star-forming regions are teeming with complex organic molecules, but the exact combination of gas-phase and grain-surface chemical processes responsible for their synthesis is intensely debated. A key question is to what extent such molecules stem from the prestellar cores that birth the protostars? The trail of water, the dominant volatile, has been intensively studied through deuteration. The HDO/H2O ratio has been used to demonstrate that the water in cores may be connected with water in protoplanetary disks, comets, and the Earth’s oceans. However, only a tentative measurement of this ratio exists for interstellar ices, where these molecules originate from. We seek to investigate the chemical composition of ices in the L1689N dark cloud that houses

the best-characterized, chemically diverse low-mass protostellar system IRAS 16293-2422 A/B, and the adjacent prestellar core I16293E with some of the highest measured levels of deuteration. With NIRSpec MOS, we will determine the abundances of CO, CO2, H2O, and CH3OH ices in at least a dozen positions in this cloud. We will verify if the tremendous chemical wealth of IRAS 16293-2422 A/B is correlated with high mthanol ice column densities as expected in the scenario of grain-surface chemistry. The requested sensitivity will constrain HDO ice in the most D-rich I16293E source. Finally, we will probe for the first time if the ice available for the formation of protostars and protoplanetary disks depends on the age of birth cloud and the number of stars that have already formed there.

OBSERVING DESCRIPTION

We propose to obtain a large (204” x 216”) view of the interstellar ices in the L1689N dark cloud that is the birth site of (i) the best-characterized, chemically most complex and rich low-mass protostellar system IRAS 16293-2422 A/B, and (ii) the adjacent prestellar core I16293E with some of the highest measured levels of deuteration. With NIRSpec MOS we will:

(1) investigate how the relative ratios of CO, CO2, and H2O ice initially available in a core may vary from the first (IRAS 16293-2422 A/B) to the second generation (I16293E) of low-mass star formation in the same dark cloud,

(2) quantify the availability of methanol ice, a key precursor for complex organic molecules in the grain-surface chemistry formation scenario, in IRAS 16293-2422 A/B;

(3) improve on a tentative HDO identification from AKARI allowing for a stringent calibration of the solid-state D/H ratio in water in I16293E alongside gas-phase measurements.

First of all, we will execute NIRCam pre-imaging of L1689N (6’x5’ FOV). This will allow us to identify all background stars in the FOV that would enable ice absorption spectra studies, including a constraint on their spectral type and stellar spectrum. We expect this number to be significantly higher than the currently known number of background stars. Based on the precise astrometry measurements from the pre-imaging, we will be able to precisely position the MSA and decide which shutters to close to avoid saturation from sources that are too bright, including the I16293A/B protostars themselves. Our choice of NIRSpec gratings and filters will allow us to cover 1.66-6.10 micron at R~2700. Against the stellar flux of the background stars, this will then allow us to probe for spectral features in absorption corresponding to CO, CO2, H2O, and CH3OH. These are the primary ice species that we seek to target in this proposal. We will obtain these full spectra towards at least a dozen of background stars behind the L1689N dark cloud thanks to the MOS mode with the MSA.

Proposal 3222 - Targets - Cask-strength clouds: high percentage of methanol and HDO ices

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	IRAS16293-MSA-POINTING	RA: 16 32 26.8400 (248.1118333d) Dec: -24 27 51.00 (-24.46417d) Equinox: J2000		
Comments: *Category=ISM* *Description=[Molecular clouds, Protostars]* *Extended=NO*				
(2)	IRAS16293-NIRCAM	RA: 16 32 25.8950 (248.1078958d) Dec: -24 28 49.60 (-24.48044d) Equinox: J2000		
Comments: Pointing at the middle point between A & B and E = (16h 32m 25.8950s, -24deg 28' 49.6") *Location between A&B = pointing of ALMA-PILS = (16h 32m 22.72s, -24deg 28' 34.3")* *Location of E = ND3 peak identified in Derek Lis's ALMA ACA observations (Fig. 6 in Lis et al. 2016, project-id: 2012.1.00178.S) = (16h 32m 29.07s, -24deg 29' 04.9")* *Category=ISM* *Description=[Molecular clouds, Protostars]* *Extended=YES*				
(3)	IRAS16293_MSA_Cat_6Feb2024	RA: 16 32 25.3272 (248.1055300d) Dec: -24 28 49.67 (-24.48046d) Equinox: J2000		
Comments: *Description=[]*				

Observation

Proposal 3222, Observation 1: IRAS16293-nircam-pre-imaging Tue Feb 06 17:00:33 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Comments: Following the review of our program by our assigned NIRCam Instrument Scientist (Martha L. Boyer), we have set a special requirement on the APA (88-91 deg) in order to avoid claws in our NIRCam images, while considering the possible APA range in our preliminary plan window (Jul 19, 2023 - Sep 8, 2023).

Diagnostics

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

(Visit 1:2) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 1:3) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 1:4) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	IRAS16293-NIRCAM	RA: 16 32 25.8950 (248.1078958d) Dec: -24 28 49.60 (-24.48044d) Equinox: J2000		

Comments: Pointing at the middle point between A & B and E = (16h 32m 25.8950s, -24deg 28' 49.6")
Location between A&B = pointing of ALMA-PILS = (16h 32m 22.72s, -24deg 28' 34.3")
Location of E = ND3 peak identified in Derek Lis's ALMA ACA observations (Fig. 6 in Lis et al. 2016, project-id: 2012.1.00178.S) = (16h 32m 29.07s, -24deg 29' 04.9")
Category=ISM
Description=[Molecular clouds, Protostars]
Extended=YES

Template

Module	Subarray	Target Placement
ALL	FULL	Module Gap

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	FULLBOX	8NIRSPEC	STANDARD		1

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F212N	F360M	BRIGHT2	5	1	8	8	858.942	144599.3
2	F200W	F480M	BRIGHT2	5	1	8	8	858.942	144599.1

Special Requirements

Sequence Visits within 53.0 Days
Aperture PA Range 88 to 91 Degrees (V3 88.0713531 to 91.0713531)
Visits Same PA

2 After 1 by 60 Days to <None specified>

Observation

Proposal 3222, Observation 2: 6Feb2024-1pntg-16-32-29.1343--24-28-39.944 Tue Feb 06 17:00:33 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec MultiObject Spectroscopy

Coordinated Parallel Template(s): NIRCam Imaging

Diagnostics

(Visit 2:1) Warning (Form): Data Excess over lower threshold

(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 2:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	IRAS16293_MSA_Cat_6Feb2024	RA: 16 32 25.3272 (248.1055300d) Dec: -24 28 49.67 (-24.48046d) Equinox: J2000		

Comments:
Description=[]

Acquisition

NIRSpec MultiObject Spectroscopy	Reference Star Bin	Target	Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	Filter: F140X; Readout: NRSRAPIDD6; 8 sources in 3 quads; [Optimal TA Accuracy]	SAME	F140X	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	

Template

NIRSpec MultiObject Spectroscopy	NIRCam Imaging
TA Method: MSATA	Module: ALL
Obtain Confirmation Images: After Target ACQ	Subarray: FULL
Science Aperture: MSA Center	Target Placement: Module Gap
Primary Candidate List: Primaries (1018 sources)	
Filler Candidate List: FIllers (499 sources)	
Spectral Overlap Map: jwst-nirspec-mr	
Spectral Overlap Threshold: 1.5	

Reference Stars

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
1	166	248.114731	-24.448769	23.958123401382224	1	625	248.144177	-24.478169	24.578940243274616
1	197	248.120292	-24.446328	23.924275537867246	1	632	248.147869	-24.478494	23.411603064422543
1	239	248.128482	-24.450020	23.607582556986344	1	636	248.151851	-24.479924	23.840767876182518
1	243	248.128925	-24.442124	24.240842650720843	1	1446	248.106231	-24.506493	24.512575906134323

Dithers

#	Dither Type
1	NONE

Confirmation

NIRSpec MultiObject Spectroscopy	Confirmation Type	Conf. Readout Pattern	Conf. Groups/Int	Conf. Integrations/Exp	Conf. Total Integrations	Conf. Total Exposure Time
1	After Target Acq	NRSIRS2RAPID	8	1	1	131.3

Spectral Elements

NIRSpec MultiObject Spectroscopy	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
1	1 (G395M/F290LP)	c1-manual_2Feb2024	3 Shutter Slitlet	248.12139291666 67 Degrees - 24.477762222222 225 Degrees	57.920236751960 85			3	15	10066.334
2	2 (G235M/F170LP)	c1-manual_2Feb2024	3 Shutter Slitlet	248.12139291666 67 Degrees - 24.477762222222 225 Degrees	57.920236751960 85			3	3	2232.1

Spectral Elements

NIRCam Imaging	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F212N	F470N+F444W	SHALLOW4	6	10	30	3	9630.883	144599.9
2	F187N	F323N+F322W2	SHALLOW4	6	2	6	3	1900.408	144599.8

Special Requirements

No Parallel Attachments
MSA Scheduled Aperture PA 57.9268 to 57.9268 Degrees (V3 279.35223 to 279.35223)

2 After 1 by 60 Days to <None specified>