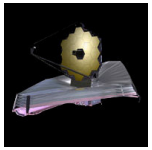

2981 - Exocometary molecules at the epoch of volatile delivery

Cycle: 2, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	HD110058	NIRSpec Fixed Slit Spectroscopy	(1) HD-110058

ABSTRACT

The presence of exocometary gas in young (10-100 Myr) debris disks presents a unique opportunity to probe the composition of exocomets during the late stages of terrestrial planet formation. This is the evolutionary stage when ice-rich impacts are proposed to change the volatile environment of terrestrial planets, setting the stage for prebiotic chemistry. In these young exocometary belts, high concentrations of debris result in frequent

collisions and release of molecular gas, which can be observed in absorption against the stellar background in edge-on systems.
We propose a JWST/NIRSpec G235H near-IR survey of exocometary molecules released in the ~15 Myr-old exocometary belt around A star HD110058. This young exocometary belt is most promising target being edge-on, and the richest in molecular CO gas based on strong absorption detected by HST-STIS, and emission detected by ALMA revealing its structure. With JWST's sensitivity in space, our main goal is to prove for the first time that exocomets hold a reservoir of H2O (and CO2), dominant species in Solar System comets, in the crucial epoch of volatile delivery where they may be transported to forming terrestrial planets.
By surveying OH, H2O, CO2, and CO with NIRSpec and exploiting the HST-JWST-ALMA synergy, we will compile a comprehensive inventory of key volatiles in a young exoplanetary system. This will allow us to conclusively determine whether exocometary compositions around HD110058 are similar to comets in our Solar System, and will demonstrate the feasibility of future exocometary compositions studies around other planetary systems with JWST.

OBSERVING DESCRIPTION

The proposal aims to detect OH, H2O, CO2, and CO gas in absorption against the stellar background in the edge-on exocometary belt around HD110058, in the 2.3-3 micron region using JWST/NIRSpec with its G235H grating. Our highest priority goal is to detect the strongest absorption line of OH (arising from the ground vibrational and rotational level, at 2.8023 micron) at the 10sigma level. Our simulation in the proposal shows that this requires achieving a SNR on the star of ~800. We use the online JWST/NIRSpec Exposure Time Calculator (ETC) to find the time required to achieve such continuum S/N at a wavelength of 2.8 micron.

For the star, we assume a point source and adopt the ETC's PHOENIX model for the spectral type closest to that of HD110058 (A5), normalized using the stars' known 2 micron flux density of 0.7 Jy. Note that the disk's dust and gas emission is cold and will be negligible in the wavelength range covered by the NIRSpec G235H filter (~$1.6-3 micron).
Given the star's brightness, to avoid saturation we choose the fixed S200A1 slit (0.2" x 3.3"), and use the SUBS200A1 subarray with the NRSRAPID readout pattern. We use the maximum number of groups possible before saturation (2), and choose 25 integrations per exposure to improve the SNR at each dither position. We then specify 10 exposures per specification, corresponding to a 5-point dither pattern x 2 (spatial) sub-pixel dither positions.

This leads to our total requested exposure time of 1174 s, corresponding to a single short visit of 1.68h total observing time (including overheads). We note that due to residual flat field noise (accounted for by the ETC) increasing the integration time further leads to diminishing returns as we approach a SNR ceiling on the stellar continuum caused by this noise source (ETC Helpdesk, private communication). Therefore, the observing

strategy should focus as much as possible on mitigating this noise source to achieve the highest possible SNR on the star, while avoiding any losses in spectral resolution.

On target acquisition: our host star HD110058 is too bright to be used for wide angle target acquisition (WATA, the optimal choice for fixed slit observations) in any of the available target acquisition filters, subarrays, and readout patterns. We therefore opt to use a nearby, fainter offset star for WATA. After inspection of ground-based optical and near-IR (2MASS) imaging, cross matched with the Gaia DR3 catalog, we identified the nearby point source 2MASS J12394454-4911583 as the most suitable candidate. The source lies ~16.5" from HD110058 in the 2MASS images, and like our target has very accurate astrometry and photometry from Gaia DR3, indicating it is a G-type star with a J band magnitude of 16.07+-0.26, corresponding to a flux density of 0.595(+0.161)(-0.127) mJy at 1.235 micron. We used the ETC to simulate target acquisition finding that the CLEAR filter, with the SUB32 subarray and the NRSRAPIDD6 readout pattern, with 3 groups per integration and just one integration, is the best choice to ensure high SNR for target acquisition (between 70-160 allowing for +-3sigma uncertainty on the flux density). Our science and acquisition targets have Gaia DR3 positions and proper motions, accurate to within 100mas, so as indicated in the NIRSpec docs we assume they are OK for offset WATA.

Proposal 2981 - Targets - Exocometary molecules at the epoch of volatile delivery

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	HD-110058	RA: 12 39 46.1475 (189.9422813d) Dec: -49 11 55.79 (-49.19883d) Equinox: J2000	Proper Motion RA: -29.847 mas/yr Proper Motion Dec: -14.979 mas/yr Parallax: 0.0076878" Epoch of Position: 2016	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[A stars]* *Extended=NO*				
(2)	2MASSJ12394454-4911583	RA: 12 39 44.4941 (189.9353921d) Dec: -49 11 58.60 (-49.19961d) Equinox: J2000	Proper Motion RA: -8.151 mas/yr Proper Motion Dec: -0.840 mas/yr Parallax: 0.0003865" Epoch of Position: 2016	
Comments: This object was generated by the targetselector and retrieved from the 2MASS database. *Category=Star* *Description=[G stars]*				

Observation

Proposal 2981, Observation 1: HD110058

Wed May 10 23:09:21 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit Spectroscopy

Diagnostics

(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)	HD-110058	RA: 12 39 46.1475 (189.9422813d) Dec: -49 11 55.79 (-49.19883d) Equinox: J2000	Proper Motion RA: -29.847 mas/yr Proper Motion Dec: -14.979 mas/yr Parallax: 0.0076878" Epoch of Position: 2016	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[A stars]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	2 2MASSJ12394454-4911583	WATA	SUB32	CLEAR	NRSRAPIDD6	3	1	1	0.26	137381.2

Template

Slit	Subarray
S200A1	SUBS200A1

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	SPATIAL

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G235H/F170LP	S200A1	NRSRAPID	2	25	1	NONE	10	250	1173.62	137381.1