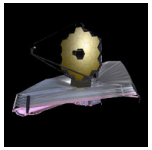

5064 - Constraining Cosmic Rays with H2 Ro-Vibrational Excitation in Dense Clouds

Cycle: 3, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	Source	NIRSpec MultiObject Spectroscopy	(1) BARNARD68
	2	Background	NIRSpec MultiObject Spectroscopy	(2) BACKGROUND-REGION

ABSTRACT

Low energy (E < 1 GeV) cosmic rays (CRs) play a key role in regulating the chemical and thermal state of molecular clouds. These CRs penetrate into the clouds' interior, ionizing H2 molecules, (i) generating gas heating, (ii) initiating chemical reactions leading to a rich array of molecules, and (iii) providing coupling of the gas to the Galactic magnetic fields. Yet, to date, the value of the CR ionization rate (CRIR), remains highly uncertain. Recently, it has been shown that the CRIR may be derived by observing H2 rovibrational emission lines in cold, dense molecular clouds. The idea is that the same CRs that provide ionization also excite the vibrational modes of H2 resulting in line emission in the near-IR with an intensity proportional to the CRIR.

We propose to observe the H2 line emission spectrum in the dark cloud Barnard 68, and obtain the CRIR.

Due to the atmospheric background, ground-based observations are not capable of detecting these faint lines. In contrast, NIRSpec/JWST can effectively detect these key H2 transitions with a high SNR. This would be the first detection of H2 vibrational emission lines in a molecular cloud and a first-time application of the H2 method for determining the CRIR. The constrained CRIR value will have direct implications on the poorly-known spectrum of low-energy proton CRs, and CR propagation theories. Furthermore, this observation will open a window for future determinations of the CRIR in the ISM in the Milky Way and beyond, shedding new light on the origin and propagation modes of Galactic CRs.

OBSERVING DESCRIPTION

We propose to observe the starless core, B68, using the MOS-NIRSpec instrument.

Since the angular size of B68 is well matched to the field of view of NIRSpec, we plan to use the MOS mode to collect light from a large portion of the cloud. In practice we use the MSA to compose a long slit, and then we will stack the spectra from all (or a significant part of the) shutters to obtain a deep spectrum.

We adopt the G235H grating because it covers the most interesting spectral region in the near-infrared range, where many CR-sensitive emission lines are found. We choose the high-resolution grating, which yields a minimal loss in SNR compared to the medium-resolution grating, because it allows us to resolve the 1-0 Q(1) line from the 1-0 Q(2) line.

Proposal 5064 - Targets - Constraining Cosmic Rays with H2 Ro-Vibrational Excitation in Dense Clouds

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	BARNARD68	RA: 17 22 38.0000 (260.6583333d) Dec: -23 49 34.00 (-23.82611d) Equinox: J2000		
Comments: *Category=ISM* *Description=[Dark interstellar clouds, Dense interstellar clouds, Interstellar clouds, Molecular gas, Nebulae]* *Extended=YES*				
(2)	BACKGROUND-REGION	RA: 17 22 38.0000 (260.6583333d) Dec: -23 19 34.00 (-23.32611d) Equinox: J2000		
Comments: *Category=Unidentified* *Description=[Blank field]* *Extended=YES*				

Observation

Proposal 5064, Observation 1: Source

Fri Mar 01 00:01:35 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec MultiObject Spectroscopy

Background Observations:[Background (Obs 2)]

Diagnostics

(Source (Obs 1)) Warning (Form): Target requiring background exposure selected for template that doesn't require background exposure

(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)	BARNARD68	RA: 17 22 38.0000 (260.6583333d) Dec: -23 49 34.00 (-23.82611d) Equinox: J2000		

Comments:
Category=ISM
Description=[Dark interstellar clouds, Dense interstellar clouds, Interstellar clouds, Molecular gas, Nebulae]
Extended=YES

Template

TA Method	Obtain Confirmation Images	Science Aperture	Primary Candidate List	Filler Candidate List	Spectral Overlap Map	Spectral Overlap Threshold
NONE	No	Q4 Field Point 1			jwst-nirspec-g235h	1.5

Spectral Elements

#	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 (G235H/F170LP)	Q4 Field Point 1 Long Slit			359.9996685371405	-10.0	-10.0	1	4	5893.912
2	1 (G235H/F170LP)	Q4 Field Point 1 Long Slit			359.9998343023914 3	-5.0	-5.0	1	4	5893.912
3	1 (G235H/F170LP)	Q4 Field Point 1 Long Slit			0.0	0.0	0.0	1	4	5893.912
4	1 (G235H/F170LP)	Q4 Field Point 1 Long Slit			1.6563063804131967E-4	5.0	5.0	1	4	5893.912
5	1 (G235H/F170LP)	Q4 Field Point 1 Long Slit			3.3119498572517 94E-4	10.0	10.0	1	4	5893.912

Special Requirements

Group Observations 1, 2, Non-interruptible

Observation

Proposal 5064, Observation 2: Background

Fri Mar 01 00:01:35 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec MultiObject Spectroscopy

Background Observation For: [Source (Obs 1)]

Diagnostics

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	BACKGROUND-REGION	RA: 17 22 38.0000 (260.6583333d) Dec: -23 19 34.00 (-23.32611d) Equinox: J2000		

Comments:
Category=Unidentified
Description=[Blank field]
Extended=YES

Template

TA Method	Obtain Confirmation Images	Science Aperture	Primary Candidate List	Filler Candidate List	Spectral Overlap Map	Spectral Overlap Threshold
NONE	No	Q4 Field Point 1			jwst-nirspec-g235h	1.5

Spectral Elements

#	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 (G235H/F170LP)	Q4 Field Point 1 Long Slit			359.9996762595778	-10.0	-10.0	1	1	1473.478
2	1 (G235H/F170LP)	Q4 Field Point 1 Long Slit			0.0	0.0	0.0	1	1	1473.478
3	1 (G235H/F170LP)	Q4 Field Point 1 Long Slit			1.6177138992392096E-4	5.0	5.0	1	1	1473.478

Special Requirements

Group Observations 1, 2, Non-interruptible