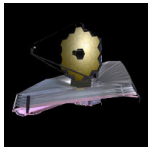

7813 - The origin of CO2 in the Uranian system and possible geologic activity at Ariel

Cycle: 4, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
Dr. Richard Cartwright (PI)	**The Johns Hopkins University Applied Physics Laboratory**
Dr. Bryan Jason Holler (CoI)	Space Telescope Science Institute
Dr. Matthew M. Hedman (CoI)	University of Idaho
Dr. Will M. Grundy (CoI)	Lowell Observatory
Dr. Marc Neveu (CoI)	University of Maryland
Dr. Lorenz Roth (CoI) (ESA Member)	Royal Institute of Technology
Dr. Jordan Kenneth Steckloff (CoI)	Planetary Science Institute
Dr. Chloe Beddingfield (CoI)	The Johns Hopkins University Applied Physics Laboratory
Tom Nordheim (CoI)	Jet Propulsion Laboratory
Dr. Geronimo Villanueva (CoI)	NASA Goddard Space Flight Center
Christopher Glein (CoI)	Southwest Research Institute
Dr. Riley DeColibus (CoI)	California Institute of Technology
Dr. Stephen Tegler (CoI)	Northern Arizona University

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Umoons				
	1	Ariel Trailing	NIRSpec IFU Spectroscopy	(1) Ariel
	2	Umbriel Trailing	NIRSpec IFU Spectroscopy	(2) Umbriel
	3	Titania Trailing	NIRSpec IFU Spectroscopy	(3) Titania
	4	Oberon Trailing	NIRSpec IFU Spectroscopy	(4) Oberon

ABSTRACT

Uranus' moons Ariel, Umbriel, Titania, and Oberon have surfaces rich in CO2 ice, and they could have subsurface saline oceans, especially Ariel. At the estimated peak surface temperatures of these moons (80-90 K), CO2 ice is volatile and should sublimate and migrate to their winter poles (20-30 K). Over time, CO2 is gradually lost due to Jeans escape and photolysis. The continued presence of CO2 indicates ongoing replenishment, either from endogenic outgassing or by radiolytic production via charged particle bombardment. Furthermore, volatile transport models suggest that the Uranian moons experience seasonal atmospheric density spikes near equinox as their cold and dark winter poles are exposed to sunlight, driving rapid sublimation of seasonal CO2 ice caps, temporarily ballooning their predicted, but yet-to-be-detected, exospheres. These seasonally-enhanced exospheres are likely very short lived, shrinking to low background levels in early spring. Ariel, however, has a young surface with large-scale fissures that might be conduits to its interior, and it exhibits some of the strongest CO2 (and CO) bands yet detected on an icy moon. Consequently, Ariel might have a sizable exosphere, sustained by venting of CO2 and CO from its interior. Cycle 4 coincides with late northern spring in the Uranus system (subsolar lat. >68ºN), long after a density spike from a devolatilized CO2 cap would have dissipated. The detection of a dense exosphere at Ariel would therefore support ongoing outgassing. We will observe these moons with NIRSpec IFU to investigate the origin of CO2 ice on all four moons (G235H) and determine whether Ariel has a geologically-sustained exosphere (G395H).

OBSERVING DESCRIPTION

We propose to make one observation of Ariel with NIRSpec IFU (G395H) and one observation each of Ariel, Umbriel, Titania, and Oberon with NIRSpec IFU (G235H), for a grand total of five NIRSpec IFU observations. All five observations will target the trailing hemispheres of these moons to measure CO2 ice on their surfaces and CO2 and CO gas in Ariel's exosphere. All exposure time estimates were made using the NIRSpec ETC, with uploaded reflectance models for these four moons. We require observations to be scheduled during JWST's leading FOR in order to keep the bright and extended disk of Uranus away from NIRSpec's MSAs. These observing requirements are included under the "Solar System Target Window" tab in the APT file and in the "Special Requirements" section of the technical case.

Proposal 7813 - Targets - The origin of CO2 in the Uranian system and possible geologic activity at Ariel

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(1)	Ariel	STD=URANUS	STD=ARIEL	
Comments: Extended=NO				
(2)	Umbriel	STD=URANUS	STD=UMBRIEL	
Comments: Extended=NO				
(3)	Titania	STD=URANUS	STD=TITANIA	
Comments: Extended=NO				
(4)	Oberon	STD=URANUS	STD=OBERON	
Comments: Extended=NO				

Observation

Proposal 7813, Observation 1: Ariel Trailing Tue Jul 15 15:00:41 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

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

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

(Ariel Trailing (Obs 1)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(1)	Ariel	STD=URANUS	STD=ARIEL	

Comments: Extended=NO

Template

TA Method	HFF Readout Mode
NONE	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	ETC Wkbk.Calc ID
1	G235H/F170LP	NRSIRS2RAPID	38	2	false	true	NONE	4	8	4551.734	
2	G395H/F290LP	NRSIRS2RAPID	64	3	false	true	NONE	4	12	11379.334	

Special Requirements

DEFAULT WINDOW: NOT OCCULTATION OF Ariel BY URANUS FROM JWST
DEFAULT WINDOW: ANGULAR RATE ARIEL FROM JWST LESS THAN 0.075
CENTRAL MERIDIAN LONGITUDE OF Ariel FROM JWST BETWEEN 225 315

Observation

Proposal 7813, Observation 2: Umbriel Trailing Tue Jul 15 15:00:41 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

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.

(Umbriel Trailing (Obs 2)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(2)	Umbriel	STD=URANUS	STD=UMBRIEL	

Comments: Extended=NO

Template

TA Method	HFF Readout Mode
NONE	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	ETC Wkbk.Calc ID
1	G235H/F170LP	NRSIRS2RAPID	60	3	false	true	NONE	4	12	10679.067	

Special Requirements

CENTRAL MERIDIAN LONGITUDE OF Umbriel FROM JWST BETWEEN 225 315
DEFAULT WINDOW: NOT OCCULTATION OF Umbriel BY URANUS FROM JWST
DEFAULT WINDOW: ANGULAR RATE UMBRIEL FROM JWST LESS THAN 0.075

Observation

Proposal 7813, Observation 3: Titania Trailing Tue Jul 15 15:00:42 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

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

(Titania Trailing (Obs 3)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(3)	Titania	STD=URANUS	STD=TITANIA	

Comments: Extended=NO

Template

TA Method	HFF Readout Mode
NONE	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	ETC Wkbk.Calc ID
1	G235H/F170LP	NRSIRS2RAPID	50	1	false	true	NONE	4	4	2976.134	

Special Requirements

CENTRAL MERIDIAN LONGITUDE OF Titania FROM JWST BETWEEN 225 315
DEFAULT WINDOW: NOT OCCULTATION OF Titania BY URANUS FROM JWST
DEFAULT WINDOW: ANGULAR RATE TITANIA FROM JWST LESS THAN 0.075

Observation

Proposal 7813, Observation 4: Oberon Trailing Tue Jul 15 15:00:42 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

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

(Oberon Trailing (Obs 4)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(4)	Oberon	STD=URANUS	STD=OBERON	

Comments: Extended=NO

Template

TA Method	HFF Readout Mode
NONE	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	ETC Wkbk.Calc ID
1	G235H/F170LP	NRSIRS2RAPID	61	1	false	true	NONE	4	4	3618.045	

Special Requirements

CENTRAL MERIDIAN LONGITUDE OF Oberon FROM JWST BETWEEN 225 315
DEFAULT WINDOW: NOT OCCULTATION OF Oberon BY URANUS FROM JWST
DEFAULT WINDOW: ANGULAR RATE OBERON FROM JWST LESS THAN 0.075