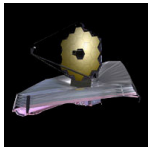

1253 - ToO Comet

Cycle: 1, Proposal Category: GTO

INVESTIGATORS

Name	*Institution*
Dr. Stefanie N. Milam (PI)	**NASA Goddard Space Flight Center**
Dr. Michael S Kelley (CoI) (CoPI) (Contact)	University of Maryland
Dr. Heidi B. Hammel (CoI)	Space Science Institute
Dr. Nathan X. Roth (CoI)	Catholic University of America
Dr. Ian Wong (CoI)	NASA Goddard Space Flight Center

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
NIRSpec				
	1	Near-IR Spectrscopy	NIRSpec IFU Spectroscopy	(1) 2022E3
	2	NIRSpec Background	NIRSpec IFU Spectroscopy	(2) 2022E3BACKGROUND
	14	NIRSpec Background (fixed target)	NIRSpec IFU Spectroscopy	(3) 2022E3-FIXED-BACKGROUND
	11	Near-IR Spectrscopy	NIRSpec IFU Spectroscopy	(1) 2022E3
	12	NIRSpec Background	NIRSpec IFU Spectroscopy	(2) 2022E3BACKGROUND
MIRI				
	3	MIRI Spectroscopy	MIRI Medium Resolution Spectroscopy	(1) 2022E3
	4	MIRI Background	MIRI Medium Resolution Spectroscopy	(2) 2022E3BACKGROUND
	13	MIRI Background (fixe d target)	MIRI Medium Resolution Spectroscopy	(3) 2022E3-FIXED-BACKGROUND

ABSTRACT

Comets and asteroids delivered pre-biotic materials to the terrestrial planet zone, providing potential catalysts for life. The abundances and spatial distributions of gas and dust in the inner coma of comets provides insight into the composition and evolution of the nucleus, which in turn provides insight into the materials delivered to the early inner Solar System. Here will conduct a full spectral study with JWST in the near infrared with JWST. Determining the volatile composition at wavelengths inaccessible from the ground will help reveal the comet's composition in parallel to observations with other facilities. We anticipate the detection of a number of known species including H2O, CO, CO2, CH3OH, and H2CO. Additionally, we will attempt to detect less abundant and possibly new species. These observations will provide context for the capability of JWST to conduct senstive near-IR spectral surveys of new dynamic objects.

We propose to observe a new dynamic comet or interstellar object, yet to be discovered during Cycle 1, or an outburst/disruption event from a known periodic comet. For comets, we find the intensity of the infrared spectral lines to scale according to a figure-of-merit (FM), given by FM = Q / (rh^2 * Delta), where Q is the water production rate (in units 1E29 molecules per second), rh is the heliocentric distance (AU) and Delta the distance to the comet (AU). Time estimates were made for a comet with FM=0.01, which typically occurs several times a year, while Q(H2O) can be determined for the trigger with high-accuracy for this activity level from other means (e.g., ground-based, radio). Our team is part of an international comet observation campaign that has successfully organized observations from facilities around the world and in space. Our science program will be activated if these approximate conditions (both comet activity and approximate location) are met and the comet’s rate of motion is within the limits of JWST’s tracking capabilities with a reaction time of a few weeks. These triggers allow for apparitions of dynamically new objects (including interstellar) and/or outbursts from known periodic comets. If we consider the historical record, we may reach the trigger criterion >3 times a year.

OBSERVING DESCRIPTION

NIRSpec and MIRI high resolution observations of a target of opportunity comet.
Here we will conduct a Target of Opportunity (ToO) spectral survey of a TBD newly-discovered comet, interstellar object, or outburst of a known object, to determine the composition of volatiles not accessible from the ground and to complement ground-based surveys. Comets and asteroids delivered pre-biotic materials to the terrestrial planet zone, providing potential catalysts for life. The abundances and spatial distributions of gas and dust in the inner coma of comets provides insight into the composition and evolution of the nucleus, which in turn provides insight into the materials delivered to the early inner Solar System. We will spectrally map gas (H2O, CO2, CO, CH4, CH3OH, and others) across the near IR spectral range of JWST.

We propose to observe a new dynamic comet, yet to be discovered during Cycle 1 (HAMMEL_207-208). For comets, we find the intensity of the infrared spectral lines to scale according to a figure-of-merit (FM), given by FM = Q / (rh^2 D), where Q is the water production rate (in units 1E29

molecules per second), rh is the heliocentric distance (AU) and delta the distance to the comet (AU). Time estimates were made for a comet with FM=0.01, which typically occurs several times a year, while Q(H2O) can be determined for the trigger with high-accuracy for this activity level from other means (e.g., ground-based, radio). Our team (led by S. Milam) is part of an international comet observation campaign that has successfully organized observations from facilities around the world and in space. Our science program will be activated if these approximate conditions (both comet activity and approximate location) are met and the comet's rate of motion is within the limits of JWST's tracking capabilities with a reaction time of a few weeks. These triggers allow for apparitions of dynamically new comets, interstellar objects, and/or outbursts from known periodic comets. If we consider the historical record, we may reach the trigger criterion >3 times a year.

The NIRSpec IFU observations are sequenced together, non-interruptable, so that the full data sets are taken under a similar rotational phase of the nucleus and other dynamic activity of these bodies. This also ensures the background observations are taken under similar conditions as the source data.

2023 Mar 01: Added fixed targets to serve as backgrounds for the executed C/2022 E3 observations. Made copies of Obs 2 and 4, accordingly. The RA and Dec is a clean part of sky near the successful on-source MIRI MRS observations.

Proposal 1253 - Targets - ToO Comet

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	2022E3-FIXED-BACKGROUND	RA: 04 36 12.0000 (69.0500000d) Dec: +01 36 23.00 (1.60639d) Equinox: J2000		

Comments: Fixed target to emulate the approximate location C/2022 E3 was observed.
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(1)	2022E3	TYPE=COMET,Q=1.112299098099895,E=1.001088207423616,I=109.1745284126515,O=302.5531808967519,W=145.824554007414,T=12-JAN-2023:19:07:49,TTimeScale=TDB,EQUINOX=J2000,EPOCH=01-MAR-2023:00:00:00,EpochTimeScale=TDB		
Comments: Extended=YES				
(2)	2022E3BACKGROUND	TYPE=COMET,Q=1.112299098099895,E=1.001088207423616,I=109.1745284126515,O=302.5531808967519,W=145.824554007414,T=12-JAN-2023:19:07:49,TTimeScale=TDB,EQUINOX=J2000,EPOCH=01-MAR-2023:00:00:00,EpochTimeScale=TDB	TYPE=POS_ANGLE,RAD=180,ANG=90,REF=SUN	
Comments: Extended=Unknown				

Observation

Proposal 1253, Observation 1: Near-IR Spectrscopy Thu Mar 02 16:00:27 GMT 2023

Diagnostic Status: Error

Observing Template: NIRSpec IFU Spectroscopy

Background Observations:[NIRSpec Background (Obs 2)]

Comments: Non-interruptible special requirement needed for observations due to the dynmaic nature of comets that can be variable on short time-scales.

Diagnostics

(Near-IR Spectrscopy (Obs 1)) Error (Form): Number of Activations is a required field.

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

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(1)	2022E3	TYPE=COMET,Q=1.112299098099895,E=1.001088207423616,I=109.1745284126515,O=302.5531808967519,W=145.824554007414,T=12-JAN-2023:19:07:49,TTimeScale=TDB,EQUINOX=J2000,EPOCH=01-MAR-2023:00:00:00,EpochTimeScale=TDB		

Comments: Extended=YES

Template

TA Method
NONE

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	G140H/F100LP	NRSIRS2RAPID	7	2	false	true	NONE	4	8	933.689	
2	G235H/F170LP	NRSIRS2RAPID	6	2	false	true	NONE	4	8	816.978	

Special Requirements

Target Of Opportunity Response Time 250 Days, Number of Activations <None specified>

Sequence Observations 1, 2, Non-interruptible

DEFAULT WINDOW: ANGULAR RATE 2022E3 FROM JWST LESS THAN 0.075

Observation

Proposal 1253, Observation 2: NIRSpec Background Thu Mar 02 16:00:27 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Background Observation For: [Near-IR Spectrscopy (Obs 1)]

Comments: Non-interruptible special requirement needed for observations due to the dynmaic nature of comets that can be variable on short time-scales.

Diagnostics

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

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(2)	2022E3BACKGROUND	TYPE=COMET,Q=1.112299098099895,E=1.001088207423616,I=109.1745284126515,O=302.5531808967519,W=145.824554007414,T=12-JAN-2023:19:07:49,TTimeScale=TDB,EQUINOX=J2000,EPOCH=01-MAR-2023:00:00:00,EpochTimeScale=TDB	TYPE=POS_ANGLE,RAD=180,ANG=90,REF=SUN	

Comments: Extended=Unknown

Template

TA Method
NONE

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	G140H/F100LP	NRSIRS2RAPID	7	2	false	true	NONE	4	8	933.689	
2	G235H/F170LP	NRSIRS2RAPID	6	2	false	true	NONE	4	8	816.978	

Special Requirements

Offset 60.0 arcsec, 60.0 arcsec

Sequence Observations 1, 2, Non-interruptible

DEFAULT WINDOW: ANGULAR RATE 2022E3BACKGROUND FROM JWST LESS THAN 0.075

Observation

Proposal 1253, Observation 14: NIRSpec Background (fixed target) Thu Mar 02 16:00:27 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

(Visit 14:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	2022E3-FIXED-BACKGROUND	RA: 04 36 12.0000 (69.0500000d) Dec: +01 36 23.00 (1.60639d) Equinox: J2000		

Comments: Fixed target to emulate the approximate location C/2022 E3 was observed.
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	4-POINT-NOD				

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	G140H/F100LP	NRSIRS2RAPID	7	2	false	true	NONE	4	8	933.689	
2	G235H/F170LP	NRSIRS2RAPID	6	2	false	true	NONE	4	8	816.978	

Special Requirements

DEFAULT WINDOW: ANGULAR RATE 2022E3BACKGROUND FROM JWST LESS THAN 0.075

Observation

Proposal 1253, Observation 11: Near-IR Spectrscopy Thu Mar 02 16:00:27 GMT 2023

Diagnostic Status: Error

Observing Template: NIRSpec IFU Spectroscopy

Background Observations:[NIRSpec Background (Obs 12)]

Comments: Non-interruptible special requirement needed for observations due to the dynmaic nature of comets that can be variable on short time-scales.

Diagnostics

(Near-IR Spectrscopy (Obs 11)) Error (Form): Number of Activations is a required field.

(Visit 11:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(1)	2022E3	TYPE=COMET,Q=1.112299098099895,E=1.001088207423616,I=109.1745284126515,O=302.5531808967519,W=145.824554007414,T=12-JAN-2023:19:07:49,TTimeScale=TDB,EQUINOX=J2000,EPOCH=01-MAR-2023:00:00:00,EpochTimeScale=TDB		

Comments: Extended=YES

Template

TA Method
NONE

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	G395H/F290LP	NRSIRS2RAPID	12	2	false	true	NONE	4	8	1517.245	

Special Requirements

Target Of Opportunity Response Time 250 Days, Number of Activations <None specified>

Sequence Observations 11, 12, Non-interruptible

DEFAULT WINDOW: ANGULAR RATE 2022E3 FROM JWST LESS THAN 0.075

Observation

Proposal 1253, Observation 12: NIRSpec Background Thu Mar 02 16:00:27 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Background Observation For: [Near-IR Spectrscopy (Obs 11)]

Comments: Non-interruptible special requirement needed for observations due to the dynmaic nature of comets that can be variable on short time-scales.

Diagnostics

(Visit 12:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(2)	2022E3BACKGROUND	TYPE=COMET,Q=1.112299098099895,E=1.001088207423616,I=109.1745284126515,O=302.5531808967519,W=145.824554007414,T=12-JAN-2023:19:07:49,TTimeScale=TDB,EQUINOX=J2000,EPOCH=01-MAR-2023:00:00:00,EpochTimeScale=TDB	TYPE=POS_ANGLE,RAD=180,ANG=90,REF=SUN	

Comments: Extended=Unknown

Template

TA Method
NONE

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	G395H/F290LP	NRSIRS2RAPID	12	2	false	true	NONE	4	8	1517.245	

Special Requirements

Offset 60.0 arcsec, 60.0 arcsec

Sequence Observations 11, 12, Non-interruptible

DEFAULT WINDOW: ANGULAR RATE 2022E3BACKGROUND FROM JWST LESS THAN 0.075

Observation

Proposal 1253, Observation 3: MIRI Spectroscopy Thu Mar 02 16:00:27 GMT 2023

Diagnostic Status: Error

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[MIRI Background (Obs 4)]

Comments: TOO Trigger
MIRI time transferred from1252

Diagnostics

(MIRI Spectroscopy (Obs 3)) Error (Form): Number of Activations is a required field.

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

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(1)	2022E3	TYPE=COMET,Q=1.112299098099895,E=1.001088207423616,I=109.1745284126515,O=302.5531808967519,W=145.824554007414,T=12-JAN-2023:19:07:49,TTimeScale=TDB,EQUINOX=J2000,EPOCH=01-MAR-2023:00:00:00,EpochTimeScale=TDB		

Comments: Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray
	ALL	NO	FULL

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	EXTENDED SOURCE	NEGATIVE

Spectral Elements

#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SHORT(A)	MRSLONG		FASTR1	20	1	1	Dither 1	4	4	222.003	
1	SHORT(A)	MRSSHORT		FASTR1	20	1	1	Dither 1	4	4	222.003	
2	MEDIUM(B)	MRSLONG		FASTR1	20	1	1	Dither 1	4	4	222.003	
2	MEDIUM(B)	MRSSHORT		FASTR1	20	1	1	Dither 1	4	4	222.003	
3	LONG(C)	MRSLONG		FASTR1	20	1	1	Dither 1	4	4	222.003	
3	LONG(C)	MRSSHORT		FASTR1	20	1	1	Dither 1	4	4	222.003	

Special Requirements	
	Target Of Opportunity Response Time 250 Days, Number of Activations <None specified> Sequence Observations 3, 4, Non-interruptible DEFAULT WINDOW: ANGULAR RATE 2022E3 FROM JWST LESS THAN 0.075

Observation

Proposal 1253, Observation 4: MIRI Background

Thu Mar 02 16:00:27 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: [MIRI Spectroscopy (Obs 3)]

Diagnostics

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

Solar System Targets

#	Name	Level 1	Level 2	Level 3
(2)	2022E3BACKGROUND	TYPE=COMET,Q=1.112299098099895,E=1.001088207423616,I=109.1745284126515,O=302.5531808967519,W=145.824554007414,T=12-JAN-2023:19:07:49,TTimeScale=TDB,EQUINOX=J2000,EPOCH=01-MAR-2023:00:00:00,EpochTimeScale=TDB	TYPE=POS_ANGLE,RAD=180,ANG=90,REF=SUN	

Comments: Extended=Unknown

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray
	ALL	NO	FULL

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	POINT SOURCE	NEGATIVE

Spectral Elements

#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SHORT(A)	MRSLONG		FASTR1	20	1	1	Dither 1	4	4	222.003	
1	SHORT(A)	MRSSHORT		FASTR1	20	1	1	Dither 1	4	4	222.003	
2	MEDIUM(B)	MRSLONG		FASTR1	20	1	1	Dither 1	4	4	222.003	
2	MEDIUM(B)	MRSSHORT		FASTR1	20	1	1	Dither 1	4	4	222.003	
3	LONG(C)	MRSLONG		FASTR1	20	1	1	Dither 1	4	4	222.003	
3	LONG(C)	MRSSHORT		FASTR1	20	1	1	Dither 1	4	4	222.003	

Special Requirements	
	Sequence Observations 3, 4, Non-interruptible DEFAULT WINDOW: ANGULAR RATE 2022E3BACKGROUND FROM JWST LESS THAN 0.075

Observation

Proposal 1253, Observation 13: MIRI Background (fixed target) Thu Mar 02 16:00:27 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Diagnostics

(Visit 13:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	2022E3-FIXED-BACKGROUND	RA: 04 36 12.0000 (69.0500000d) Dec: +01 36 23.00 (1.60639d) Equinox: J2000		

Comments: Fixed target to emulate the approximate location C/2022 E3 was observed.
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray
	ALL	NO	FULL

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	POINT SOURCE	NEGATIVE

Spectral Elements

#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SHORT(A)	MRSLONG		FASTR1	20	1	1	Dither 1	4	4	222.003	
1	SHORT(A)	MRSSHORT		FASTR1	20	1	1	Dither 1	4	4	222.003	
2	MEDIUM(B)	MRSLONG		FASTR1	20	1	1	Dither 1	4	4	222.003	
2	MEDIUM(B)	MRSSHORT		FASTR1	20	1	1	Dither 1	4	4	222.003	
3	LONG(C)	MRSLONG		FASTR1	20	1	1	Dither 1	4	4	222.003	
3	LONG(C)	MRSSHORT		FASTR1	20	1	1	Dither 1	4	4	222.003	

Special Requirements	DEFAULT WINDOW: ANGULAR RATE 2022E3BACKGROUND FROM JWST LESS THAN 0.075