



2876 - Probing Water Ice in Distant Comets: Crystalline or Amorphous?

Cycle: 2, Proposal Category: GO

INVESTIGATORS

<i>Name</i>	<i>Institution</i>
Dr. Bin Yang (PI)	Planetary Science Institute
Dr. Michael S Kelley (CoI) (CoPI)	University of Maryland
Dr. Silvia Protopapa (CoI)	Southwest Research Institute

OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Distant Comet Observation				
	1	C2019E3 NIRSpec	NIRSpec IFU Spectroscopy	(1) C-2019-E3
	2	C2019E3 Background	NIRSpec IFU Spectroscopy	(4) C-2019-E3-OFFSET
	3	C2020F2 NIRSpec	NIRSpec IFU Spectroscopy	(2) C-2020-F2
	4	C2020F2 Background	NIRSpec IFU Spectroscopy	(5) C-2020-F2-OFFSET
	5	C2019O3 NIRspec	NIRSpec IFU Spectroscopy	(3) C-2019-O3
	6	C2019O3 Background	NIRSpec IFU Spectroscopy	(6) C-2019-O3-OFFSET

ABSTRACT

Water ice plays a key role in the early stages of planet formation. Characterizing water ice, especially in comets, can yield important insights into the formation of planetary Systems, the origins of planetary atmospheres, and the source of Earth's oceans. However, studying the properties of cometary water ice has been challenging, and our knowledge of primordial ice remains highly limited. Recent JWST observations of the largest Oort Cloud comet, C/2014 UN271, reveal the unexpected presence of a significant amount of crystalline ice in this distant comet, which should be composed solely of amorphous water ice. The surprising discovery made by JWST challenges our current understanding of comet formation in the outer protoplanetary disk. On the other hand, C/2014 UN271 is a large comet (>100 km) and thus could have experienced internal heating. It also underwent multiple outbursts recently. Therefore, the detected crystalline ice may not be primordial but a result of surface or internal alteration

processes. With this new detection, JWST has finally opened the window to study water ice in comets, a key piece needed to understand the formation of the Solar system. To exploit this unprecedented opportunity, we propose NIRSpec observations of three kilometer-sized distant comets which have never shown outbursts and are expected to have retained their primordial state. Our study will provide strong observational evidence to answer the hotly debated questions: What is the water ice content of comets? What were the required conditions for the formation of the protoplanetary disk from the Solar Nebula?

OBSERVING DESCRIPTION

We propose to observe three distant comets, using NIRSpec IFU prism mode from 0.8 to 5.2 micron, to search for water ice features at 1.5, 2.0 and 3.0 micron, respectively. All IFU observations have dedicated backgrounds.

For each comet, the science observation and the background observation are sequenced together, non-interruptable. This ensures the background observations are taken under similar conditions as the source data.

Proposal 2876 - Targets - Probing Water Ice in Distant Comets: Crystalline or Amorphous?

#	Name	Level 1	Level 2	Level 3
(1)	C-2019-E3	TYPE=COMET,Q=10.31374394985054,E=1.0019253 93001824,I=84.29743644860524 ,O=347.2536254895184,W=280.6497112728948,T=13 -NOV- 2023:21:27:19,TTIME=J2000,E POCH=03-MAR- 2022:00:00:00,EpochTimeScale=TDB		
<i>Comments: Extended=YES</i>				
(2)	C-2020-F2	TYPE=COMET,Q=8.817025446187381,E=1.0047488 20254508,I=163.5833817903565 ,O=250.2670048640452,W=48.36226286990362,T=15 -JUL- 2022:22:32:28,TTIME=J2000,E POCH=17-MAR- 2022:00:00:00,EpochTimeScale=TDB		
<i>Comments: Extended=YES</i>				
(3)	C-2019-O3	TYPE=COMET,Q=8.819960272683293,E=1.0035355 97735441,I=89.81864037906573 ,O=300.3914854864776,W=60.09424773598611,T=08 -MAR- 2021:20:32:58,TTIME=J2000,E POCH=04-MAR- 2022:00:00:00,EpochTimeScale=TDB		
<i>Comments: Extended=YES</i>				
(4)	C-2019-E3-OFFSET	TYPE=COMET,Q=10.31374394985054,E=1.0019253 93001824,I=84.29743644860524 ,O=347.2536254895184,W=280.6497112728948,T=13 -NOV- 2023:21:27:19,TTIME=J2000,E POCH=03-MAR- 2022:00:00:00,EpochTimeScale=TDB	TYPE=POS_ANGLE,RAD=60,ANG=180,REF=NOR TH	
<i>Comments: Extended=YES</i>				
(5)	C-2020-F2-OFFSET	TYPE=COMET,Q=8.817025446187381,E=1.0047488 20254508,I=163.5833817903565 ,O=250.2670048640452,W=48.36226286990362,T=15 -JUL- 2022:22:32:28,TTIME=J2000,E POCH=17-MAR- 2022:00:00:00,EpochTimeScale=TDB	TYPE=POS_ANGLE,RAD=60,ANG=225,REF=NOR TH	
<i>Comments: Extended=YES</i>				
(6)	C-2019-O3-OFFSET	TYPE=COMET,Q=8.819960272683293,E=1.0035355 97735441,I=89.81864037906573 ,O=300.3914854864776,W=60.09424773598611,T=08 -MAR- 2021:20:32:58,TTIME=J2000,E POCH=04-MAR- 2022:00:00:00,EpochTimeScale=TDB	TYPE=POS_ANGLE,RAD=60,ANG=270,REF=NOR TH	
<i>Comments: Extended=YES</i>				

Solar System Targets

Proposal 2876 - Observation 1 - Probing Water Ice in Distant Comets: Crystalline or Amorphous?

Fri Mar 29 23:00:35 GMT 2024

Observation	Proposal 2876, Observation 1: C2019E3 NIRSpec Diagnostic Status: Warning Observing Template: NIRSpec IFU Spectroscopy Background Observations:[C2019E3 Background (Obs 2)]											
	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (C2019E3 NIRSpec (Obs 1)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.											
Diagnosics												
Solar System Targets	#	Name	Level 1				Level 2				Level 3	
	(1)	C-2019-E3	TYPE=COMET,Q=10.31374394985054,E=1.0019253 93001824,I=84.29743644860524 ,O=347.2536254895184,W=280.6497112728948,T=13 -NOV- 2023:21:27:19,TimeScale=TDB,EQUINOX=J2000,E POCH=03-MAR- 2022:00:00:00,EpochTimeScale=TDB <i>Comments: Extended=YES</i>									
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	PRISM/CLEAR	NRSIRS2	8	1	false	true	NONE	4	4	2392.578	142557
Special Requirements	Sequence Observations 1, 2, Non-interruptible											
	DEFAULT WINDOW: ANGULAR RATE C-2019-E3 FROM JWST LESS THAN 0.075											

Proposal 2876 - Observation 2 - Probing Water Ice in Distant Comets: Crystalline or Amorphous?

Fri Mar 29 23:00:35 GMT 2024

Observation	Proposal 2876, Observation 2: C2019E3 Background Diagnostic Status: Warning Observing Template: NIRSpec IFU Spectroscopy Background Observation For: [C2019E3 NIRSpec (Obs 1)] <i>Comments: Sky background observation for comet C/2019 E3</i>											
	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (C2019E3 Background (Obs 2)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.											
Diagnostics												
Solar System Targets	#	Name	Level 1				Level 2				Level 3	
	(4)	C-2019-E3-OFFSET	TYPE=COMET,Q=10.31374394985054,E=1.0019253 93001824,I=84.29743644860524 ,O=347.2536254895184,W=280.6497112728948,T=13 -NOV- 2023:21:27:19,TimeScale=TDB,EQUINOX=J2000,E POCH=03-MAR- 2022:00:00:00,EpochTimeScale=TDB				TYPE=POS_ANGLE,RAD=60,ANG=180,REF=NOR TH					
<i>Comments: Extended=YES</i>												
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	PRISM/CLEAR	NRSIRS2	8	1	false	true	NONE	4	4	2392.578	142557
Special Requirements	Sequence Observations 1, 2, Non-interruptible											
	DEFAULT WINDOW: ANGULAR RATE C-2019-E3-OFFSET FROM JWST LESS THAN 0.075											

Proposal 2876 - Observation 3 - Probing Water Ice in Distant Comets: Crystalline or Amorphous?

Fri Mar 29 23:00:35 GMT 2024

Observation	Proposal 2876, Observation 3: C2020F2 NIRSpec Diagnostic Status: Warning Observing Template: NIRSpec IFU Spectroscopy Background Observations:[C2020F2 Background (Obs 4)]											
	(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (C2020F2 NIRSpec (Obs 3)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.											
Diagnosics												
Solar System Targets	#	Name	Level 1				Level 2				Level 3	
	(2)	C-2020-F2	TYPE=COMET,Q=8.817025446187381,E=1.0047488 20254508,I=163.5833817903565 ,O=250.2670048640452,W=48.36226286990362,T=15 -JUL- 2022:22:32:28,TimeScale=TDB,EQUINOX=J2000,E POCH=17-MAR- 2022:00:00:00,EpochTimeScale=TDB									
<i>Comments: Extended=YES</i>												
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	PRISM/CLEAR	NRSIRS2	15	1	false	true	NONE	4	4	4435.023	142557
Special Requirements	Sequence Observations 3, 4, Non-interruptible											
	DEFAULT WINDOW: ANGULAR RATE C-2020-F2 FROM JWST LESS THAN 0.075											

Proposal 2876 - Observation 4 - Probing Water Ice in Distant Comets: Crystalline or Amorphous?

Fri Mar 29 23:00:35 GMT 2024

Observation	Proposal 2876, Observation 4: C2020F2 Background Diagnostic Status: Warning Observing Template: NIRSpec IFU Spectroscopy Background Observation For: [C2020F2 NIRSpec (Obs 3)] <i>Comments: Sky background observation for comet C/2020 F2</i>											
	(Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (C2020F2 Background (Obs 4)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.											
Diagnostics												
Solar System Targets	#	Name	Level 1				Level 2				Level 3	
	(5)	C-2020-F2-OFFSET	TYPE=COMET,Q=8.817025446187381,E=1.0047488 20254508,I=163.5833817903565 ,O=250.2670048640452,W=48.36226286990362,T=15 -JUL- 2022:22:32:28,TTimeScale=TDB,EQUINOX=J2000,E POCH=17-MAR- 2022:00:00:00,EpochTimeScale=TDB				TYPE=POS_ANGLE,RAD=60,ANG=225,REF=NOR TH					
<i>Comments: Extended=YES</i>												
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	PRISM/CLEAR	NRSIRS2	15	1	false	true	NONE	4	4	4435.023	142557
Special Requirements	Sequence Observations 3, 4, Non-interruptible											
	DEFAULT WINDOW: ANGULAR RATE C-2020-F2-OFFSET FROM JWST LESS THAN 0.075											

Proposal 2876 - Observation 5 - Probing Water Ice in Distant Comets: Crystalline or Amorphous?

Fri Mar 29 23:00:35 GMT 2024

Observation	Proposal 2876, Observation 5: C2019O3 NIRspec Diagnostic Status: Warning Observing Template: NIRSpec IFU Spectroscopy Background Observations:[C2019O3 Background (Obs 6)]											
	(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (C2019O3 NIRspec (Obs 5)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.											
Diagnosics												
Solar System Targets	#	Name	Level 1				Level 2				Level 3	
	(3)	C-2019-O3	TYPE=COMET,Q=8.819960272683293,E=1.0035355 97735441,I=89.81864037906573 ,O=300.3914854864776,W=60.09424773598611,T=08 -MAR- 2021:20:32:58,TTimeScale=TDB,EQUINOX=J2000,E POCH=04-MAR- 2022:00:00:00,EpochTimeScale=TDB <i>Comments: Extended=YES</i>									
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	PRISM/CLEAR	NRSIRS2	9	1	false	true	NONE	4	4	2684.356	142557
Special Requirements	Sequence Observations 5, 6, Non-interruptible											
	DEFAULT WINDOW: ANGULAR RATE C-2019-O3 FROM JWST LESS THAN 0.075											

Proposal 2876 - Observation 6 - Probing Water Ice in Distant Comets: Crystalline or Amorphous?

Fri Mar 29 23:00:35 GMT 2024

Observation	Proposal 2876, Observation 6: C2019O3 Background Diagnostic Status: Warning Observing Template: NIRSpec IFU Spectroscopy Background Observation For: [C2019O3 NIRspec (Obs 5)] Comments: Sky background observation for comet C/2019 O3											
	(Visit 6:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (C2019O3 Background (Obs 6)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.											
Diagnosics												
Solar System Targets	#	Name	Level 1				Level 2				Level 3	
	(6)	C-2019-O3-OFFSET	TYPE=COMET,Q=8.819960272683293,E=1.0035355 97735441,I=89.81864037906573 ,O=300.3914854864776,W=60.09424773598611,T=08 -MAR- 2021:20:32:58,TTimeScale=TDB,EQUINOX=J2000,E POCH=04-MAR- 2022:00:00:00,EpochTimeScale=TDB				TYPE=POS_ANGLE,RAD=60,ANG=270,REF=NOR TH					
Comments: 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	PRISM/CLEAR	NRSIRS2	9	1	false	true	NONE	4	4	2684.356	142557
Special Requirements	Sequence Observations 5, 6, Non-interruptible											
	DEFAULT WINDOW: ANGULAR RATE C-2019-O3-OFFSET FROM JWST LESS THAN 0.075											