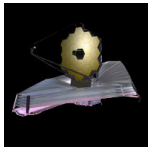

1959 - Ice chemical complexity toward the Ophiuchus molecular cloud

Cycle: 1, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
Dr. Will Rocha (PI) (ESA Member)	**Universiteit Leiden**
Prof. Jes K. Jorgensen (CoI) (ESA Member)	University of Copenhagen, Niels Bohr Institute
Dr. Lars E. Kristensen (CoI) (ESA Member)	University of Copenhagen, Niels Bohr Institute
Dr. Giulia Perotti (CoI) (ESA Member)	Max Planck Institute for Astronomy
Dr. Agata Karska (CoI) (ESA Member)	Nicolaus Copernicus University in Torun

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	GSS30_MIRI	MIRI Medium Resolution Spectroscopy	(1) GSS-30
	9	OphA_BKG_MIRI	MIRI Medium Resolution Spectroscopy	(7) OPHA-BKG
	2	GY92 197_MIRI	MIRI Medium Resolution Spectroscopy	(2) GY92-197
	5	CRBR2422.8-3423 MIRI	MIRI Medium Resolution Spectroscopy	(4) CRBR-2422.8-3423
	6	WL17 MIRI	MIRI Medium Resolution Spectroscopy	(5) WL-17
	11	GY9291 MIRI	MIRI Medium Resolution Spectroscopy	(9) GY9291
	10	OphE_BKG_MIRI	MIRI Medium Resolution Spectroscopy	(8) OPHE-BKG
	8	CRBR2315 MIRI	MIRI Medium Resolution Spectroscopy	(6) CRBR-2315.8-1700

ABSTRACT

An unsolved problem in the context of the chemical composition of star-forming regions is how complex organic molecules (COMs) are produced. The current consensus is that such molecules are formed in ice mantles on dust grain and then released to the gas-phase upon heating or irradiation by photons or cosmic-rays. However, while a wealth of COMs has been detected in the gas-phase toward hot cores and hot corinos with

millimeter/submillimeter observations, only methanol, the precursor of some COMs, has been securely identified in the ice phase. Laboratory experiments have shown that large molecules are formed in the ice-phase, thus suggesting that interstellar ices hold large reservoirs of COMs.

With this proposal, we aim to answer: (i) What is the origin of COMs in ices and their abundances? (ii) How does the external UV irradiation of OB stars affects the formation of COMs in protostellar cores? and (iii) How do COM abundances depend on the ice structure (amorphous and crystalline)? We propose mid-infrared observations with MIRI/MRS toward six protostars located in the Ophiuchus Molecular Cloud and close to two OB stars, S1 and HD147889. The resolution (R~2500) and sensitivity (S/N > 300) provided by MIRI will allow us to identify and resolve narrow spectral bands associated with COMs, such as acetaldehyde and ethanol. They can be formed from energetic processing of methanol ice with UV photons and cosmic rays. In particular, ethanol is a precursor of glycolaldehyde, a building block of amino acids. Additionally, the IFU spectroscopy will allow us to map the distribution of ices around the YSOs and stablish correlations with the environment (e.g., UV irradiation field).

OBSERVING DESCRIPTION

The study of interstellar ices is essential to understand the initial conditions of star and planet formation. In this regard, JWST will provide, for the first time, enough spectral resolution (R ~ 2500) and sensitivity (S/N ~ 300) to detect absorption bands of complex organic molecules in the icy grain mantles. We thus propose mid-infrared observations with the MIRI/MRS spectrometer of six protostars located in the Ophiuchus Molecular Cloud, which is surrounded by three OB stars with luminosities of 1100-4500 Lsun. These JWST/MIRI observations will cover key spectral range where complex organic molecules (COMs) can be identified, namely, 5-20 micron range. Additionally, with the IFU spectroscopic technique available in this observing mode, we will obtain spatial and spectral information, thus allowing us to map the ice distributions around each protostar, and better trace variations from source to source. Our scientific goals with this proposal are to (1) address the composition of the interstellar ice in the Ophiuchus cloud, in particular, acetaldehyde, ethanol, glycolaldehyde and ethylene glycol, which can be formed from the energetic processing of ices containing methanol; (2) study how COM abundances depends on the ice morphology (amorphous or crystalline), and (3) understand the impact of the external UV irradiation on the presence or absence of COMs. Achieving these goals is essential to finally understand the origin of COMs in star-forming regions and how the chemical complexity in the ices are comparable with molecules detected in comets in our Solar System.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	GSS-30	RA: 16 26 21.3816 (246.5890900d) Dec: -24 23 4.05 (-24.38446d) Equinox: J2000	Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Young stellar objects]* *Extended=YES*				
(2)	GY92-197	RA: 16 27 5.2462 (246.7718592d) Dec: -24 36 29.79 (-24.60827d) Equinox: J2000	Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Young stellar objects]* *Extended=YES*				
(4)	CRBR-2422.8-3423	RA: 16 27 24.5993 (246.8524971d) Dec: -24 41 3.73 (-24.68437d) Equinox: J2000	Proper Motion RA: -8.95128236952998E-4 sec of time/yr Proper Motion Dec: -0.020800000083909254 arcsec/yr Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Young stellar objects]* *Extended=YES*				
(5)	WL-17	RA: 16 27 6.7648 (246.7781867d) Dec: -24 38 15.43 (-24.63762d) Equinox: J2000	Proper Motion RA: -7.334368566266267E-4 sec of time/yr Proper Motion Dec: -0.027900000031877425 arcsec/yr Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Young stellar objects]* *Extended=YES*				
(6)	CRBR-2315.8-1700	RA: 16 26 17.2294 (246.5717892d) Dec: -24 23 45.37 (-24.39594d) Equinox: J2000	Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Young stellar objects]* *Extended=YES*				
(7)	OPHA-BKG	RA: 16 26 2.5000 (246.5104167d) Dec: -24 29 53.80 (-24.49828d) Equinox: J2000		
Comments: *Category=Calibration* *Description=[Telescope/sky background]* *Extended=YES*				
(8)	OPHE-BKG	RA: 16 27 19.2290 (246.8301208d) Dec: -24 34 33.62 (-24.57601d) Equinox: J2000		
Comments: *Category=Calibration* *Description=[Telescope/sky background]* *Extended=YES*				

	(9)	GY9291	RA: 16 26 49.4695 (246.7061229d) Dec: -24 27 14.47 (-24.45402d) Equinox: J2000
	Comments: *Category=Star* *Description=[Young stellar objects]* *Extended=YES*		

Observation

Proposal 1959, Observation 1: GSS30_MIRI Tue Aug 01 05:01:43 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[OphA_BKG_MIRI (Obs 9)]

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)	GSS-30	RA: 16 26 21.3816 (246.5890900d) Dec: -24 23 4.05 (-24.38446d) Equinox: J2000	Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Young stellar objects]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
F560W	ALL	NO	FULL	NEUTRAL

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	LONG(C)	MRSLONG		FASTR1	5	1	1	Dither 1	4	4	55.501	
1	LONG(C)	MRSSHORT		FASTR1	5	1	1	Dither 1	4	4	55.501	
2	MEDIUM(B)	MRSLONG		FASTR1	5	1	1	Dither 1	4	4	55.501	
2	MEDIUM(B)	MRSSHORT		FASTR1	5	1	1	Dither 1	4	4	55.501	
3	SHORT(A)	MRSLONG		FASTR1	5	1	1	Dither 1	4	4	55.501	
3	SHORT(A)	MRSSHORT		FASTR1	5	1	1	Dither 1	4	4	55.501	

Special Requirements	Sequence Observations 1, 8, 9, Non-interruptible

Observation

Proposal 1959, Observation 9: OphA_BKG_MIRI Tue Aug 01 05:01:43 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: [GSS30_MIRI (Obs 1), CRBR2315 MIRI (Obs 8)]

Diagnostics

(Visit 9:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(7)	OPHA-BKG	RA: 16 26 2.5000 (246.5104167d) Dec: -24 29 53.80 (-24.49828d) Equinox: J2000		

Comments:
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
F560W	ALL	NO	FULL	NEUTRAL

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	LONG(C)	MRSLONG		FASTR1	5	1	1	Dither 1	4	4	55.501	
1	LONG(C)	MRSSHORT		FASTR1	5	1	1	Dither 1	4	4	55.501	
2	MEDIUM(B)	MRSLONG		FASTR1	5	1	1	Dither 1	4	4	55.501	
2	MEDIUM(B)	MRSSHORT		FASTR1	5	1	1	Dither 1	4	4	55.501	
3	SHORT(A)	MRSLONG		FASTR1	5	1	1	Dither 1	4	4	55.501	
3	SHORT(A)	MRSSHORT		FASTR1	5	1	1	Dither 1	4	4	55.501	

Special Requirements	Sequence Observations 1, 8, 9, Non-interruptible

Observation

Proposal 1959, Observation 2: GY92 197_MIRI Tue Aug 01 05:01:43 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[OphE_BKG_MIRI (Obs 10)]

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)	GY92-197	RA: 16 27 5.2462 (246.7718592d) Dec: -24 36 29.79 (-24.60827d) Equinox: J2000	Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Young stellar objects]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	ALL	NO	FULL	NEUTRAL

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	45	1	1	Dither 1	4	4	499.507	
1	SHORT(A)	MRSSHORT		FASTR1	45	1	1	Dither 1	4	4	499.507	
2	MEDIUM(B)	MRSLONG		FASTR1	45	1	1	Dither 1	4	4	499.507	
2	MEDIUM(B)	MRSSHORT		FASTR1	45	1	1	Dither 1	4	4	499.507	
3	LONG(C)	MRSLONG		FASTR1	45	1	1	Dither 1	4	4	499.507	
3	LONG(C)	MRSSHORT		FASTR1	45	1	1	Dither 1	4	4	499.507	

Special Requirements	Sequence Observations 2, 5, 6, 10, 11, Non-interruptible

Observation

Proposal 1959, Observation 5: CRBR2422.8-3423 MIRI Tue Aug 01 05:01:43 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[OphE_BKG_MIRI (Obs 10)]

Diagnostics

(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(4)	CRBR-2422.8-3423	RA: 16 27 24.5993 (246.8524971d) Dec: -24 41 3.73 (-24.68437d) Equinox: J2000	Proper Motion RA: -8.95128236952998E-4 sec of time/yr Proper Motion Dec: -0.020800000083909254 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Young stellar objects]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	ALL	NO	FULL	NEUTRAL

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	2	1	Dither 1	4	8	455.107	
2	MEDIUM(B)	MRSSHORT		FASTR1	20	2	1	Dither 1	4	8	455.107	
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	
	No Parallel Attachments Sequence Observations 2, 5, 6, 10, 11, Non-interruptible

Observation

Proposal 1959, Observation 6: WL17 MIRI Tue Aug 01 05:01:43 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[OphE_BKG_MIRI (Obs 10)]

Diagnostics

(Visit 6:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(5)	WL-17	RA: 16 27 6.7648 (246.7781867d) Dec: -24 38 15.43 (-24.63762d) Equinox: J2000	Proper Motion RA: -7.334368566266267E-4 sec of time/yr Proper Motion Dec: -0.027900000031877425 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Young stellar objects]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	ALL	NO	FULL	NEUTRAL

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	25	1	1	Dither 1	4	4	277.504	
1	SHORT(A)	MRSSHORT		FASTR1	25	1	1	Dither 1	4	4	277.504	
2	MEDIUM(B)	MRSLONG		FASTR1	25	1	1	Dither 1	4	4	277.504	
2	MEDIUM(B)	MRSSHORT		FASTR1	25	1	1	Dither 1	4	4	277.504	
3	LONG(C)	MRSLONG		FASTR1	25	1	1	Dither 1	4	4	277.504	
3	LONG(C)	MRSSHORT		FASTR1	25	1	1	Dither 1	4	4	277.504	

Special Requirements	Sequence Observations 2, 5, 6, 10, 11, Non-interruptible

Observation

Proposal 1959, Observation 11: GY9291 MIRI Tue Aug 01 05:01:43 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[OphE_BKG_MIRI (Obs 10)]

Diagnostics

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(9)	GY9291	RA: 16 26 49.4695 (246.7061229d) Dec: -24 27 14.47 (-24.45402d) Equinox: J2000		

Comments:
Category=Star
Description=[Young stellar objects]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	ALL	NO	FULL	NEUTRAL

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	25	2	1	Dither 1	4	8	566.108	
1	SHORT(A)	MRSSHORT		FASTR1	25	2	1	Dither 1	4	8	566.108	
2	MEDIUM(B)	MRSLONG		FASTR1	25	2	1	Dither 1	4	8	566.108	
2	MEDIUM(B)	MRSSHORT		FASTR1	25	2	1	Dither 1	4	8	566.108	
3	LONG(C)	MRSLONG		FASTR1	25	2	1	Dither 1	4	8	566.108	
3	LONG(C)	MRSSHORT		FASTR1	25	2	1	Dither 1	4	8	566.108	

Special Requirements	Sequence Observations 2, 5, 6, 10, 11, Non-interruptible

Observation

Proposal 1959, Observation 10: OphE_BKG_MIRI Tue Aug 01 05:01:43 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: [GY92 197_MIRI (Obs 2), CRBR2422.8-3423 MIRI (Obs 5), WL17 MIRI (Obs 6), GY9291 MIRI (Obs 11)]

Diagnostics

(Visit 10:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(8)	OPHE-BKG	RA: 16 27 19.2290 (246.8301208d) Dec: -24 34 33.62 (-24.57601d) Equinox: J2000		

Comments:
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	ALL	NO	FULL	NEUTRAL

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	25	1	1	Dither 1	4	4	277.504	
1	SHORT(A)	MRSSHORT		FASTR1	25	1	1	Dither 1	4	4	277.504	
2	MEDIUM(B)	MRSLONG		FASTR1	25	1	1	Dither 1	4	4	277.504	
2	MEDIUM(B)	MRSSHORT		FASTR1	25	1	1	Dither 1	4	4	277.504	
3	LONG(C)	MRSLONG		FASTR1	25	1	1	Dither 1	4	4	277.504	
3	LONG(C)	MRSSHORT		FASTR1	25	1	1	Dither 1	4	4	277.504	

Special Requirements	Sequence Observations 2, 5, 6, 10, 11, Non-interruptible

Observation

Proposal 1959, Observation 8: CRBR2315 MIRI Tue Aug 01 05:01:43 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[OphA_BKG_MIRI (Obs 9)]

Diagnostics

(Visit 8:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(6)	CRBR-2315.8-1700	RA: 16 26 17.2294 (246.5717892d) Dec: -24 23 45.37 (-24.39594d) Equinox: J2000	Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Young stellar objects]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	ALL	NO	FULL	NEUTRAL

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	LONG(C)	MRSLONG		FASTR1	25	1	1	Dither 1	4	4	277.504	
1	LONG(C)	MRSSHORT		FASTR1	25	1	1	Dither 1	4	4	277.504	
2	MEDIUM(B)	MRSLONG		FASTR1	25	1	1	Dither 1	4	4	277.504	
2	MEDIUM(B)	MRSSHORT		FASTR1	25	1	1	Dither 1	4	4	277.504	
3	SHORT(A)	MRSLONG		FASTR1	25	1	1	Dither 1	4	4	277.504	
3	SHORT(A)	MRSSHORT		FASTR1	25	1	1	Dither 1	4	4	277.504	

Special Requirements	Sequence Observations 1, 8, 9, Non-interruptible