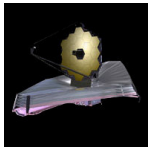

2581 - Come Out, Come Out, Wherever You Are: Seeking All the Massive Young Clusters Hidden in the Antennae

Cycle: 1, Proposal Category: GO

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Rupali Chandar (PI)	**University of Toledo**	**rupali.chandar@utoledo.edu**
Prof. Alberto Bolatto (CoI)	University of Maryland	bolatto@umd.edu
Dr. Daniel Dale (CoI)	University of Wyoming	ddale@uwyo.edu
Dr. Paul Goudfrooij (CoI)	Space Telescope Science Institute	goudfroo@stsci.edu
Prof. Ralf Stephan Klessen (CoI) (ESA Member)	Zentrum fur Astronomie - Universitat Heidelberg	klessen@uni-heidelberg.de
Dr. Angus Mok (CoI) (CSA Member)	OCAD University	mok.angus@gmail.com
Dr. Eva Schinnerer (CoI) (ESA Member)	Max-Planck-Institut fur Astronomie, Heidelberg	schinner@mpia.de
Prof. JD Smith (CoI)	University of Toledo	jd.smith@utoledo.edu
Dr. Fabian Walter (CoI) (ESA Member)	Max-Planck-Institut fur Astronomie, Heidelberg	walter@mpia.de

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Overlap Region				
	1	NIRCAM Overlap	NIRCam Imaging	(1) ANTENNAE-NIRCAM
	2	MIRI Overlap	MIRI Imaging	(2) ANTENNAE-MIRI

ABSTRACT

The so-called ‘overlap’ region of the nearby merging Antennae galaxies provides a unique laboratory to study the formation of young globular clusters. While Hubble has already revealed some of these massive young clusters in the optical and near-infrared, the vast majority remain hidden behind large amounts of dust which reach extinction values as high as Av~30 mag. JWST now enables the characterization (ages/masses) of

essentially ALL deeply buried young (<10 Myr), massive (>10,000 Msun) clusters in the dusty overlap region for the first time, using NIRCam & MIRI imaging. From the resulting complete catalog of young massive clusters (including optically selected ones from HST), we will determine the fraction of stars formed in clusters & construct and fit the initial cluster mass function. The results will be compared with predictions from hydrodynamic simulations which use a large range of prescriptions for star formation and stellar feedback in galaxy mergers. A comparison between the mass function of clusters and molecular clouds detected in available ALMA observations will yield estimates of the star cluster formation efficiency. Maps of 3.3 to 7.7 micron PAH emission will help diagnose grain sizes in this extreme star-forming environment. The strong IR emission from luminous infrared galaxies (LIRGs) usually comes from a combination of star formation and an accreting AGN; the Antennae present a unique case where the IR emission is driven only by star formation. This system therefore provides a critical bridge between star formation processes in normal (disk) galaxies, and the more intensely star-forming galaxies commonly found in the young and distant universe.

OBSERVING DESCRIPTION

We will observe the intensely star-forming overlap region and northern disk of the Antennae galaxies with NIRCam and MIRI Imaging.

We propose single-module NIRCAM imaging (which covers the region of interest) in a total of 5 filters. Two of them cover the hydrogen emission lines Paschen alpha (F187N) and Brackett alpha (F410M), and two others cover adjacent featureless continuum (F150W and F360M). Since the required exposure time in the F150W filter is approximately double that required for the filters in the long-wavelength arm of NIRCam, we break those observations into 2 sets, and include a filter covering the PAH 3.3 micron feature (F335M) in one of those.

We use a mosaic of two MIRI pointings to cover the same part of the Antennae to observe the 7.7 micron PAH feature (F770W).

We optimize the mutual NIRCam and MIRI imaging coverage by using two separate targets (one for each instrument) along with the OFFSET special requirement to adjust the nominal pointing (i.e., the aperture) for each instrument to a location near a detector center, since the default apertures for NIRCam and MIRI imaging are not adequate in this context.

We impose an orientation (PA_V3) range of ~100 degrees in order to keep the northern disk within the NIRCam field of view, which gives ~50 days of schedulability during the year. We allow the MIRI observation to have an Aperture PA within +/- 10 degrees of that of the NIRCam observation.

Readout patterns will be SHALLOW4 (NIRCam) and FAST (MIRI), in order to end up with at least 5 groups per integration, which will help with cosmic ray removal.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	ANTENNAE-NIRCAM	RA: 12 01 55.4837 (180.4811821d) Dec: -18 52 22.64 (-18.87296d) Equinox: J2000	Proper Motion RA: 0.0001 mas/yr Proper Motion Dec: 0.0001 mas/yr Epoch of Position: 2000	
Comments: Works well for the selected NIRCam pointing, optimizing allowable ORIENT range *Category=Galaxy* *Description=[Galaxy disks, Infrared galaxies, Interacting galaxies]*				
(2)	ANTENNAE-MIRI	RA: 12 01 53.8030 (180.4741792d) Dec: -18 52 14.23 (-18.87062d) Equinox: J2000	Proper Motion RA: 0.0001 mas/yr Proper Motion Dec: 0.0001 mas/yr Epoch of Position: 2000	
Comments: Works well for the selected MIRI 1x2 mosaic, optimizing allowable ORIENT range *Category=Galaxy* *Description=[Galaxy disks, Infrared galaxies, Interacting galaxies]*				

Observation

Proposal 2581, Observation 1: NIRCAM Overlap

Fri May 20 14:00:42 GMT 2022

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

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)	ANTENNAE-NIRCAM	RA: 12 01 55.4837 (180.4811821d)	Proper Motion RA: 0.0001 mas/yr	
		Dec: -18 52 22.64 (-18.87296d)	Proper Motion Dec: 0.0001 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

Comments: Works well for the selected NIRCam pointing, optimizing allowable ORIENT range
Category=Galaxy
Description=[Galaxy disks, Infrared galaxies, Interacting galaxies]

Template

Module	Subarray
B	FULL

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	INTRAMODULEBOX	4	SMALL-GRID-DITHER		3

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F187N	F335M	SHALLOW4	6	1	12	12	3736.396	61329
2	F150W	F360M	SHALLOW4	6	1	12	12	3736.396	61329
3	F150W	F410M	SHALLOW4	6	1	12	12	3736.396	61329

Special Requirements

Aperture PA Range 103 to 116 Degrees (V3 102.97547802 to 115.97547802)
Offset 29.17 arcsec, 38.43 arcsec
Background Limited. Background no more than 40th percentile above minimum

Group Observations 1, 2 within 5 Days
Aperture PA Offset 2 from 1 by -10 to 5 Degrees (V3 -14.80973126 to 0.19026874)

Observation

Proposal 2581, Observation 2: MIRI Overlap Fri May 20 14:00:42 GMT 2022

Diagnostic Status: Warning

Observing Template: MIRI Imaging

Diagnostics

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

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	ANTENNAE-MIRI	RA: 12 01 53.8030 (180.4741792d)	Proper Motion RA: 0.0001 mas/yr	
		Dec: -18 52 14.23 (-18.87062d)	Proper Motion Dec: 0.0001 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

Comments: Works well for the selected MIRI 1x2 mosaic, optimizing allowable ORIENT range
Category=Galaxy
Description=[Galaxy disks, Infrared galaxies, Interacting galaxies]

Template

Subarray
FULL

Mosaic

Rows	Columns	Row Overlap %	Column Overlap %	Row shift	Column shift	Tile Order
1	2	10.0	10.0	0.0	0.0	DEFAULT

Dithers

#	Dither Type	Starting Point	Number of Points	Points	Starting Set	Number of Sets	Optimized For	Direction	Pattern Size
1	4-Point-Sets				6	1	POINT SOURCE	POSITIVE	DEFAULT

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F770W	FASTR1	22	1	1	Dither 1	4	4	244.204	61329

Special Requirements

Group Visits within 53.0 Days
Visits Same PA
Offset 20.0 arcsec, -5.0 arcsec

Group Observations 1, 2 within 5 Days
Aperture PA Offset 2 from 1 by -10 to 5 Degrees (V3 -14.80973126 to 0.19026874)