



1226 - Star formation in the local group - NGC 2070 (30 Dor)

Cycle: 1, Proposal Category: GTO

INVESTIGATORS

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Prof. Nino Panagia (CoI) (US Admin CoI)	Space Telescope Science Institute
Dr. Elena Sabbi (CoI)	Space Telescope Science Institute

OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1		NIRSpec MultiObject Spectroscopy	(1) 47-eMPTselected+allTA
	2		NIRSpec MultiObject Spectroscopy	(2) 48-eMPTselected+allTA

ABSTRACT

This sub-program will showcase the multi-object spectroscopy capabilities of NIRSpec for stellar studies. We will obtain medium- and high-resolution spectroscopy of hundreds of known pre-main sequence (PMS) stars of different ages, hosted in massive starburst clusters located in different environments (metallicity) in the Local Group. The target clusters are NGC 3603 in the Galaxy, 30 Dor in the Large Magellanic Cloud, and NGC 346 in the Small Magellanic Cloud. These PMS stars have been identified photometrically as objects with strong H excess emission and

equivalent width exceeding 10 \AA , and as such appear to be actively accreting from a circumstellar disc. While for many of these objects comparison with isochrones suggests young ages of the order of a few Myr, a large number of them appear older than 20 Myr, suggesting that in these environments accretion onto PMS stars lasts longer than in small nearby Galactic star forming regions. These NIRSpec observations will allow us to obtain accurate accretion luminosities, mass accretion rates, and in-falling gas kinematics for all these stars from the analysis of several Hydrogen recombination lines (Pa, Br, Br). The ultimate scientific goal of this project is to understand the very nature of the mass accretion process, and how it depends on the mass, age, and metallicity of the individual objects. This study is unique since existing spectroscopy of PMS stars is so far limited to the solar neighborhood and no information exists for starburst clusters or for non-solar metallicity. Coordinated NIRCам parallel observations in the periphery of the same star-forming regions will support the primary science program: by revealing many more PMS stars of lower mass, they will considerably extend both the number of targets and the parameter space in this investigation.

This APT file covers the observations of NGC 2070 (30 Dor) and the list of observation IDs is: FERRUIT_6201, FERRUIT_6251, FERRUIT_6252, FERRUIT_6253

OBSERVING DESCRIPTION

Primary observations with NIRSpec

The NIRSpec primary observations are conceptually simple. We already know from accurate HST photometry in the V, I and H α bands the positions of PMS stars actively undergoing accretion in the fields of interest with 5 mas relative accuracy. Since the reference stars used for target acquisition are part of the same photometric catalogue, these observations do not need NIRCам pre-imaging.

The exact MSA configuration will only be generated when the assigned telescope orientation is known. However, with the typical density of primary targets (PMS stars) in our field of interest, extensive MPT simulations show that, regardless of orientation, at least 50 of these PMS stars can be placed within the acceptance zone of a MSA shutter, while still having the two neighbouring shutters in the cross dispersion direction free from other stars for background determination. Furthermore, the MSA configuration will be completed with a limited number (~10) filler targets, namely older main-sequence and red-giant stars with similar colours as the PMS objects but no H α excess emission that are very abundant in the field. The typical MSA configuration will include ~60 targets.

The MSA is configured in slitlet mode, so the dithering strategy to mitigate possible detector blemishes consists simply in a slew along the slitlet by one or two micro-shutters. Observations in the standard slitlet mode will simplify background subtraction, as per the standard NIRSpec pipeline.

The two practical goals of these observations are: (1) to measure spectroscopically the accretion luminosity and mass accretion rates of the target stars, to confirm that they are all accreting, even the older objects; and (2) to study more in-depth the accretion process, namely the kinematics and physical properties of the infalling gas.

For the first goal, we need to measure emission signatures in the Hydrogen recombination lines sampled by the spectra. Resolution $R=1000$ is sufficient to derive the equivalent width and luminosity of these lines. The G235M/F170LP combination provides simultaneous access to Pa alpha, and Br beta and Br gamma. We will use two different MSA configurations with G235M/F170LP, to secure about ~ 100 PMS spectra. The typical magnitude of these sources is $K_{\{AB\}} \sim 23.5$ and with typical exposure times of ~ 2500 s we will reach $SNR \sim 10$ in the continuum at 2 micron. A first result of this project will be the independent spectroscopic determination of the accretion luminosities of these PMS stars from multiple lines. Furthermore, we will look for correlations between the accretion luminosity and age, since the stars are known to have considerably different ages.

Coordinated parallel observations with NIRCcam

The NIRCcam parallel observations consist of imaging in the F150W, F187N, and F182M bands for the short-wavelength (SW) camera and in the F277W, F405N, and F430M bands for the long-wavelength (LW) camera. In order to most effectively identify objects with excess emission in the Pa alpha and Br alpha bands, it is important to reach similar continuum magnitude levels in the narrow bands as well as in the neighbouring broad bands. The NIRCcam exposure time calculator indicates that for a typical PMS star with effective temperature $T_{\text{eff}} \sim 4000$ K, reaching the same SNR in F187N and F405N as in the neighbouring broad bands requires exposures in principle almost 20 times longer. Hence, a considerable fraction of the total exposure time (about 3/4) is devoted to the narrow bands.

The dithering pattern is set by NIRSspec's nodding in the slitlet approach. Therefore, the dithering pattern for NIRCcam is fully constrained both in time and offset. The NIRSspec pointings with G235M/F170LP accommodate multiple nodding sequences, with ~ 7 min exposures (10 groups) and two different MSA configurations, for a total of 4 nodding sequences. During each nodding sequence the NIRCcam filter does not change. One sequence has the F150W/F277W pair, one sequence has the F182M/F430M pair, and two sequences have the F187N/F405N+F444W pair. During both nodding sequences the NIRCcam filter pair is always F187N/F405N+F444W.

Proposal 1226 - Targets - Star formation in the local group - NGC 2070 (30 Dor)

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	47-eMPTselected+allTA	RA: 05 38 50.8200 (84.7117500d) Dec: -69 04 45.06 (-69.07918d) Equinox: J2000		
	<i>Comments:</i> Description=[]				
(2)	48-eMPTselected+allTA	RA: 05 37 59.7221 (84.4988421d) Dec: -69 10 14.20 (-69.17061d) Equinox: J2000			
	<i>Comments:</i> Description=[]				

Proposal 1226 - Observation 1 - Star formation in the local group - NGC 2070 (30 Dor)

Tue Jun 06 21:00:43 GMT 2023

Observation	Proposal 1226, Observation 1 Diagnostic Status: Warning Observing Template: NIRSpec MultiObject Spectroscopy Coordinated Parallel Template(s): NIRCam Imaging																																																												
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Proposal 1226 - Observation 1 - Star formation in the local group - NGC 2070 (30 Dor)

Spectral Elements	NIRSpec	Exposure	MSA	Nod Pattern	Pointing	Aperture PA	Dispersion Offset	Cross-Dispersion	Total Dithers	Total	Total Exposure
	MultiObject	Specification	Configuration				(Shutters)	Offset (Shutters)		Integrations	Time
	Spectroscopy										
1		1 (G235M/F170LP)	c1	3 Shutter Slitlet	84.705618749999 99 Degrees - 69.086675000000 01 Degrees	336.15740830144 165			3	3	1444.3
2		2 (G235M/F170LP)	c1	3 Shutter Slitlet	84.705618749999 99 Degrees - 69.086675000000 01 Degrees	336.15740830144 165			3	3	1444.3
Spectral Elements	NIRCam Imaging	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure	ETC Wkbk.Calc	
									Time	ID	
1		F187N	F405N+F444W	SHALLOW2	9	1	3	3	1352.833		
2		F182M	F430M	SHALLOW2	9	1	3	3	1352.833		
Special Requirements	Aperture PA Range 336.1517 to 336.1517 Degrees (V3 197.5771303 to 197.5771303) [MSA Selected]										
	No Parallel Attachments MSA Scheduled Aperture PA 336.1517 to 336.1517 Degrees (V3 197.5771303 to 197.5771303)										

Proposal 1226 - Observation 2 - Star formation in the local group - NGC 2070 (30 Dor)

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Observation	Proposal 1226, Observation 2 Diagnostic Status: Warning Observing Template: NIRSpec MultiObject Spectroscopy Coordinated Parallel Template(s): NIRCam Imaging																																																																																																		
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1		1 (G235M/F170LP)	c2	3 Shutter Slitlet	84.493060416666 67 Degrees - 69.184677777777 78 Degrees	336.15708042572 13			3	3	1444.3
2		2 (G235M/F170LP)	c2	3 Shutter Slitlet	84.493060416666 67 Degrees - 69.184677777777 78 Degrees	336.15708042572 13			3	3	1444.3
3		3 (G235M/F170LP)	c2	3 Shutter Slitlet	84.493060416666 67 Degrees - 69.184677777777 78 Degrees	336.15708042572 13			3	3	1444.3
Spectral Elements	NIRCam Imaging	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure	ETC Wkbk.Calc	
									Time	ID	
1		F187N	F405N+F444W	SHALLOW2	9	1	3	3	1352.833		
2		F212N	F470N+F444W	SHALLOW2	9	1	3	3	1352.833		
3		F200W	F444W	SHALLOW2	9	1	3	3	1352.833		
Special Requirements	Aperture PA Range 336.1517 to 336.1517 Degrees (V3 197.5771303 to 197.5771303) [MSA Selected]										
	No Parallel Attachments MSA Scheduled Aperture PA 336.1517 to 336.1517 Degrees (V3 197.5771303 to 197.5771303)										