7035 - Brown Dwarfs in NGC 602 in the SMC - An opportunity to characterize a substellar IMF at low metallicity

Cycle: 4, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	Observation	Label	Observing Template	Science Target
NIRCam				
	6		NIRCam Imaging	(1) NGC-602
NIRSpec				

Folder	Observation	Label	Observing Template	Science Target
	3	APA80	NIRSpec MultiObject Spectroscopy	(2) APT_cat

ABSTRACT

We propose to exploit the synergy of NIRCam and NIRSpec to characterize, for the first time, the initial mass function (IMF) down to 15 Jupiter masses in NGC 602, a low-metallicity (1/5 Solar) young star cluster in the Small Magellanic Cloud (SMC). NGC 602 formed in an isolated location in the "wing" of the SMC, still it hosts numerous OB stars. It is the only low-metallicity young (about 2 Myr) star cluster where, with JWST, planetary-mass Brown Dwarfs have been detected, thus offering an opportunity to study the impact of stellar feedback from OB stars across the cluster region. We will collect tens of NIRSpec spectra of young, low-metallicity Brown Dwarfs. By targeting a completely unexplored parameter space (young and low metallicity), we will assemble a unique dataset that will have long-lasting legacy value for all the studies of Brown Dwarf formation, especially at sub-Solar metallicity. Only combining deep NIRCam photometry and NIRSpec MOS it is possible to derive accurate spectral-type-based masses and measure ages better than 0.5 Myr using evolutionary models and spectral templates. This dataset will add an invaluable piece to the puzzle of the formation of sub stellar objects at conditions that are different than Solar, and will address the environmental condition impact on the young star cluster IMF.

OBSERVING DESCRIPTION

The goals of this proposal are deep NIRCam photometry and NIRSpec MOS to measure the sub-stellar initial mass function (IMF) down to 15 Jupiter masses and obtain the first spectra of around 45 young Brown Dwarfs (BDs) outside the Milky Way.

NIRCam photometry:

To fulfill our science goals of characterizing the sub-stellar IMF down to 15 Jupiter masses we request NIRCam photometry in 6 different filters: F140M, F162M, F182M, F277W, F360M, F444W. This combination of medium and wide-band filters is necessary to separate BDs from main sequence stars using CMDs and two-color diagrams by targeting H2O absorption bands (F140M, F182M) + continuum (F162M) and CH4 (F360M), which are much deeper in BDs compared to low-mass stars. Two continuum filters (F277W, F444W) will show infrared excess in PMS stars and reveal the very different SED shape of background galaxies. To reach a S/N >10 in all filters a total integration time per filter of 41,744s is needed. To optimally cover the cluster region and simultaneously observe a background field West of NGC 602 possible due to the large field of view of NIRCam, we will use the FULLBOX 6 dither pattern. Additionally, we apply 9 subpixel dithers allowing us to optimally sample the PSF, which is particularly important at short wavelengths, where the NIRCam detector is under sampled. We chose the readout pattern MEDIUM2 with 8 groups and 1 integration each, which is a good compromise between data volume, to avoid data excess warnings allowing maximum flexibility for

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scheduling, and dynamic range. We will utilize readout groups 0 and 1 as well as the archival data of program GO-2662 to recover most of the bright, saturated point sources.

NIRSpec MOS:

To obtain around 45 BD spectra and 30 low-mass PMS spectra in PRISM mode 3 individual MOS configurations are required. With a total exposure time of 27,835s per configuration a continuum S/N>15 can be reached for all objects above 50 Jupiter masses. We use the NRSIRS2 readout pattern, which suppresses the 1/f noise thus improving the S/N. We apply 3-point nods to subtract the local background. Each observation requires 6 integrations with 21 groups each leaving the exposure time per integration at ~1550s, which is sufficiently short to avoid severe impacts from comsic rays, as recommened by the NIRSpec team. The many isolated point sources in the region are sufficient for MSATA.

	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
Fixed Targets	(1)	NGC-602	RA: 01 29 13.1798 (22.3049158d)	Epoch of Position: 2000	
			Dec: -73 33 40.72 (-73.56131d)		
			Equinox: J2000		
	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.				
	Category=Stellar Cluster				
	Description=[Young star clusters]				
	(2)	APT_cat	RA: 01 29 27.8070 (22.3658625d)		
			Dec: -73 33 30.48 (-73.55847d)		
			Equinox: J2000		
	Comments:				
	Description=[]				

Observation

Proposal 7035, Observation 6	Thu May 01 13:00:28 GMT 2025
Diagnostic Status: Warning	
Observing Template: NIRCam Imaging	

Diagnostics

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

(Visit 6:2) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 6:3) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 6:4) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 6:5) Warning (Form): Overheads are provisional until the Visit Planner has been run.

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	NGC-602	RA: 01 29 13.1798 (22.3049158d)	Epoch of Position: 2000	
		Dec: -73 33 40.72 (-73.56131d)		
		Equinox: J2000		

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Stellar Cluster
Description=[Young star clusters]

Template

Module	Subarray	Target Placement
ALL	FULL	Module Gap

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	FULLBOX	6	STANDARD		9

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F140M	F360M	MEDIUM2	8	1	54	54	41744.562	
2	F162M+F150W2	F277W	MEDIUM2	8	1	54	54	41744.562	
3	F182M	F444W	MEDIUM2	8	1	54	54	41744.562	

Special Requirements

Sequence Visits within 53.0 Days
Aperture PA Range 169.92542306 to 209.92542306 Degrees (V3 170.0 to 210.0)
Aperture PA Range 349.92542306 to 29.92542306 Degrees (V3 350.0 to 30.0)
Visits Same PA

Observation

Proposal 7035, Observation 3: APA80   Thu May 01 13:00:29 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec MultiObject Spectroscopy

Diagnostics

(APA80 (Obs 3)) Warning (Form): Config c1 (#1) has 1 filler slit traces affected by failed open shutters.

(APA80 (Obs 3)) Warning (Form): Config c1 (#1) has 1 filler slits affected by failed closed shutters.

(APA80 (Obs 3)) Warning (Form): Config c2 (#2) has 1 filler slit traces affected by failed open shutters.

(APA80 (Obs 3)) Warning (Form): Config c3 (#3) has 1 filler slit traces affected by failed open shutters.

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

(Visit 3:2) Warning (Form): Overheads are provisional until the Visit Planner has been run.

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	APT_cat	RA: 01 29 27.8070 (22.3658625d)		
		Dec: -73 33 30.48 (-73.55847d)		
		Equinox: J2000		

Comments:
Description=[]

Acquisition

#	Reference Star Bin	Target	Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	Filter: F110W; Readout: NRSRAPIDD6; 8 sources in 3 quads; [Optimal TA Accuracy]	SAME	F110W	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	
2	Filter: F110W; Readout: NRSRAPIDD6; 8 sources in 2 quads; [Optimal TA Accuracy]	SAME	F110W	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	
3		SAME	F140X	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	

Template

TA Method	HFF Readout Mode	Obtain Confirmation Images	Science Aperture	Primary Candidate List	Filler Candidate List	Spectral Overlap Map	Spectral Overlap Threshold
MSATA	false	No	MSA Center	BDs+low_mass_PMS (210 sources)	YSOs_PMS (2130 sources)	jwst-nirspec-prism	1.5

Reference Stars

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
1	2197	22.387087	-73.588213	22.585991750912264	1	10865	22.441277	-73.572110	22.685355114873666
1	2201	22.363707	-73.587955	21.947972911383474	1	11167	22.434344	-73.546578	22.86372994657824
1	2249	22.383426	-73.586209	22.864228665595533	1	11325	22.482622	-73.540826	21.716571156878842
1	2261	22.399920	-73.585585	22.514513301629655	1	11344	22.438898	-73.539801	22.035954823524563

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
2	6038	22.314020	-73.579673	23.28213275232708	2	7981	22.264138	-73.578863	22.037694330776233
2	6062	22.310839	-73.578637	23.123238658217524	2	7995	22.250214	-73.578227	22.78203538162314
2	6297	22.306762	-73.569517	22.91394125960717	2	8009	22.255824	-73.577322	22.885301996283907
2	6478	22.306332	-73.564022	23.297049643803845	2	9995	22.234153	-73.533466	22.79704359775866

Spectral Elements

#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
1	1 (PRISM/CLEAR)	c1	3 Shutter Slitlet	22.417134208333337 Degrees - 73.5689836111111 Degrees	79.95082093244547			3	18	27835.602
2	1 (PRISM/CLEAR)	c2	3 Shutter Slitlet	22.326219208333335 Degrees - 73.54954194444446 Degrees	80.03802538667367			3	18	27835.602
3	1 (PRISM/CLEAR)	c3	3 Shutter Slitlet	22.433084083333334 Degrees - 73.57213805555557 Degrees	79.93552174605692			3	18	27835.602

Special Requirements

Group Visits within 53.0 Days
Aperture PA Range 50 to 120 Degrees (V3 271.4254303 to 341.4254303)
Aperture PA Range 230 to 300 Degrees (V3 91.4254303 to 161.4254303)
Visits Same PA
MSA Planned Aperture PA 80.0000 to 80.0000 Degrees (V3 301.4254303 to 301.4254303)