



12583 - The Dragon survey: A Direct Probe of the Early Stellar Luminosity Function and Dark Matter through Multi-cycle Multi-cadence Microlensing at $z=0.73$

Cycle: 5, Proposal Category: GO

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OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	201	epoch-2-00d-JH-RK	NIRCam Imaging	(1) ABELL370

ABSTRACT

The discovery of microlensed, individual stars at cosmological distance represents one of the major advances in extragalactic astronomy over the past decade. Recently, JWST has serendipitously discovered 44 strongly lensed stars from a single galaxy, the “Dragon arc” at $z=0.73$ behind the galaxy cluster Abell 370 ($z=0.375$) in just two epochs. This observation proves that JWST has opened a new window for statistical studies of individual stars in the distant Universe, which will deliver new insights on the physics of star formation and dark matter. We propose a multi-cycle, multi-epoch, and multi-filter imaging survey to systematically capture microlensed, transient individual stars in the Dragon arc. Built upon existing serendipitous observations, our optimized survey will detect >200 individual stars over a wide range of stellar types / temperatures with well-sampled light curves through multiplex cadence, paving a new parameter space for ground-breaking discoveries. We will (1) directly model the bright-end stellar luminosity function and thus the initial mass function in a $z=0.73$ star-forming galaxy. We will also measure the spatial distributions and timescales of microlensed stars, to (2) unveil the existence of dark matter subhalos and test for primordial black holes and wave dark matter. The proposed observations in Cycle-4 (35 hours), Cycle-5 and Cycle-6 (9.5 hours each) will efficiently survey the multiplex cadences corresponding to several transient timescales. Finally, this survey will build an extragalactic ultra-deep field on Abell 370, revealing high-redshift dwarf galaxies at $z>9$ and even $z>16$ by taking the advantages of cluster lensing magnification.

OBSERVING DESCRIPTION

This is a continuation of JWST Cycle-4 GO-7345. This Cycle-5 component will obtain one epoch of deep NIRCcam images of galaxy cluster Abell 370 and the Dragon Arc at $z=0.73$. The observation will use the F115W, F200W, F277W, and F356W filters.

Below is the original observing description for the Cycle-4 Program.

We propose a multiple-cycle, multiple-cadence, and multiple-filter survey of the Dragon arc at $z=0.73$ behind the Abell 370 cluster ($z=0.375$). Recent JWST observations of the Dragon arc found it is possible to detect a large number of microlensed stars in the Dragon arc. In the proposed observations, we aim perform a multi-band survey of microlensed stars from the Dragon arc. As individual stars appear as transient events due to microlensing, time-domain observations are the core design of the proposed observations. Through the proposed time-domain aided by the multiplex cadence observations, we aim to identify >200 microlensed individual stars from the distant galaxy.

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The observation use F115W, F200W, F277W, and F356W filters for low cadence observations (Obs 101, 104, 105, and cycle-5/cycle-6 execution), and F200W and F277W filters for the high cadence observations (Obs 102, 103). F200W difference images are used to detect relatively low-temperature stars $T_{\text{eff}}=3000$ to 9000K and F115W differential images are used to detect higher temperature stars with $T_{\text{eff}}=9000$ to $\sim 20000\text{K}$. At the same time we will constrain light curves of the detected microlensed stars using long- to short-cadenced observations. We request to achieve 29.5mag at 5sigma for each filter image. Therefore, we request to perform two times F200W+F277W observations and four times F115W+F356W observations with each observation has total exposure time of 3736s. We will use both modules A and B, and perform primary dither of INTRAMODULEX with three primary dithers and 2 subpixel dither to achieve the secure coverage of the field and PSF sampling at the same time.

To securely capture transient microlensed stars with the theoretically predicted cadence and constrain several parameters, we request to execute the observation 0-day (first observation), 2-hours, 3-day, 10-day, 30-day, 180-day, 1-year, 2-year after the first observation. When combined with Cycle-1 JWST observation, we can achieve the 6-year cadenced observation. To make the observation schedulable, we set buffer periods in each observation. In particular, 3-day observation can be executed between 2 and 5 days after the 0-day, 10-day observation can be executed between 8 and 12 days after the 0-day, and 30-day observation can be executed between 25 and 35 days after the 0-day observations. The 180-day observation will be observed more than 150 days after the 0-day observations. We then request Cycle-5 and Cycle-6 observations anytime during the Cycle-5 and Cycle-6. To avoid meteorite, we request to perform 0-day (this includes 2-hours observation), 3-day, 10-day, 30-day observation during December where the risk of the micro-meteorites is low. However, to achieve the science goals, we request 180-day observation during August window when the micro-meteorite risk might be slightly higher.

Proposal 12583 - Targets - The Dragon survey: A Direct Probe of the Early Stellar Luminosity Function and Dark Matter through Multi-...

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	ABELL370	RA: 02 39 54.0850 (39.9753542d) Dec: -01 34 41.76 (-1.57827d) Equinox: J2000		
<i>Comments:</i> Category=Clusters of Galaxies Description=[Abell clusters]					

Proposal 12583 - Observation 201 - The Dragon survey: A Direct Probe of the Early Stellar Luminosity Function and Dark Matter throu...

Thu Apr 09 23:00:15 GMT 2026

Observation	<p>Proposal 12583, Observation 201: epoch-2-00d-JH-RK</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCcam Imaging</p>									
Diagnostics	(Visit 201:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections			Miscellaneous		
	(1)	ABELL370	RA: 02 39 54.0850 (39.9753542d) Dec: -01 34 41.76 (-1.57827d) Equinox: J2000							
	<p><i>Comments:</i> Category=Clusters of Galaxies Description=[Abell clusters]</p>									
Template	Module		Subarray			Target Placement				
	ALL		FULL			Module B center (small extended source)				
Dithers	#	Primary Dither Type		Primary Dithers	Subpixel Dither Type		Dither Size	Subpixel Positions		
	1	INTRAMODULEX		3	STANDARD			2		
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	Optional ETC ID
	1	F200W	F277W	MEDIUM8	6	1	6	6	3736.396	
	2	F115W	F356W	MEDIUM8	6	1	6	6	3736.396	
	3	F115W	F356W	MEDIUM8	6	1	6	6	3736.396	
	4	F200W	F277W	MEDIUM8	6	1	6	6	3736.396	
	5	F115W	F356W	MEDIUM8	6	1	6	6	3736.396	
	6	F115W	F356W	MEDIUM8	6	1	6	6	3736.396	
Special Requirements	<p>After Date 01-OCT-2026:00:00:00 Aperture PA Range 60 to 67 Degrees (V3 59.94737309 to 66.94737309) Offset -15.0 arcsec, 8.5 arcsec Fiducial Point Override NRCBS_FULL</p>									