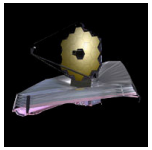

7345 - The Dragon survey: A Direct Probe of the Early Stellar Luminosity Function and Dark Matter through Multi-cycle Multi-cadence Microlensing at z=0.73

Cycle: 4, Proposal Category: GO

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	101	epoch-1-00d-JH-RK	NIRCam Imaging	(1) ABELL370
	102	epoch-1-03d-JH	NIRCam Imaging	(1) ABELL370
	103	epoch-1-10d-JH	NIRCam Imaging	(1) ABELL370
	104	epoch-1-30d-JH-RK	NIRCam Imaging	(1) ABELL370

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
	105	epoch-1-180d-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

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.

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_eff=3000 to 9000K and F115W differential images are used to detect higher temperature stars with T_eff=9000 to ~20000K. 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.

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		

Comments:
Category=Clusters of Galaxies
Description=[Abell clusters]

Observation

Proposal 7345, Observation 101: epoch-1-00d-JH-RK

Fri Jan 09 18:00:14 GMT 2026

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Diagnostics

(Visit 101:1) 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		

Comments:
Category=Clusters of Galaxies
Description=[Abell clusters]

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

After Date 01-OCT-2025:00:00:00
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

102 After 101 by 2 Days to 5 Days
103 After 101 by 8 Days to 12 Days
104 After 101 by 25 Days to 35 Days

Observation

Proposal 7345, Observation 102: epoch-1-03d-JH

Fri Jan 09 18:00:14 GMT 2026

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Diagnostics

(Visit 102:1) 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		

Comments:
Category=Clusters of Galaxies
Description=[Abell clusters]

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	F200W	F277W	MEDIUM8	6	1	6	6	3736.396	

Special Requirements

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

102 After 101 by 2 Days to 5 Days

Observation

Proposal 7345, Observation 103: epoch-1-10d-JH

Fri Jan 09 18:00:14 GMT 2026

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Diagnostics

(Visit 103:1) 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		

Comments:
Category=Clusters of Galaxies
Description=[Abell clusters]

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	F200W	F277W	MEDIUM8	6	1	6	6	3736.396	

Special Requirements

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

103 After 101 by 8 Days to 12 Days

Observation

Proposal 7345, Observation 104: epoch-1-30d-JH-RK

Fri Jan 09 18:00:14 GMT 2026

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Diagnostics

(Visit 104:1) 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		

Comments:
Category=Clusters of Galaxies
Description=[Abell clusters]

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

Aperture PA Range 60 to 67 Degrees (V3 59.94737309 to 66.94737309)
Offset -12.0 arcsec, 8.5 arcsec
Fiducial Point Override NRCBS_FULL

104 After 101 by 25 Days to 35 Days

Observation

Proposal 7345, Observation 105: epoch-1-180d-JH-RK Fri Jan 09 18:00:14 GMT 2026

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Diagnostics

(Visit 105:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 105:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

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		

Comments:
Category=Clusters of Galaxies
Description=[Abell clusters]

Template

Module	Subarray	Target Placement
ALL	FULL	Module A 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

Aperture PA Range 243 to 253 Degrees (V3 243.13434768 to 253.13434768)
Offset -31.0 arcsec, -41.0 arcsec
Fiducial Point Override NRCAS_FULL