

3840 - JWST NIRCam Confirmation of the First Directly Imaged Sub-Saturn Mass

Exoplanet

Cycle: 2, Proposal Category: GO

INVESTIGATORS

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Dr. Per Calissendorff (CoI)	University of Michigan

OBSERVATIONS

Folder Observation Label		Label	Observing Template	Science Target
Young	M Dwarf Sequen	ice 1		
	1	2MJ0944 roll 1	NIRCam Coronagraphic Imaging	(1) 2MJ0944
	2	2MJ0944 roll 2	NIRCam Coronagraphic Imaging	(1) 2MJ0944
	3	V-AP-COL roll 1	NIRCam Coronagraphic Imaging	(2) V-AP-COL

ABSTRACT

JWST Proposal 3840 (Created: Thursday, December 14, 2023 at 7:00:27 PM Eastern Standard Time) - Overview

Around nearby M dwarf stars, ground and space based high-contrast imaging has historically struggled to probe below 1 Jupiter mass at large separations. This population of planets remains poorly constrained around the most common stars in the Galaxy. However, a JWST NIRCam 3-5 micron coronagraphic imaging survey of nearby young M dwarfs reveals routine senstivity to sub-Jupiter mass planets at wide separations (>10 AU). These data have allowed the identification of a first of its kind sub-Saturn mass exoplanet candidate associated with a young M dwarf in the Solar neighborhood. The candidate is 21 mag at F444W and detected at >5 sigma significance. It remains undetected at F356W and limits on its color are consistent with model predictions for young sub-Saturn mass exoplanets. The candidate's photometric properties also rule out common stellar and galactic background sources as contaminants. This candidate is unprecendented and its confirmation can only be pursued by JWST. Here we propose a small 8.88 h program to confirm this sub-Saturn via deeper coronagraphic imaging and a detailed astrometric analysis to verify common proper motion with the putative host star. This is easily achieveble given the star's proper motion (0.33"/yr), the >=11 months between the first observation and those proposed here, and the high astrometric accuracy achievable with NIRCam. Confirmation of this young sub-Saturn candidate will provide the first key constraints on the luminosity and early evolution of low-mass gas giants. It will also drive future theoretical work to model its properties, and undoubtedly lead to future JWST direct imaging to further charcterize this exciting candidate.

OBSERVING DESCRIPTION

We propose 8.88 h of JWST NIRCam coronagraphic imaging to follow up and confirm the first directly detected sub-Saturn exoplanet candidate. We will observe the science target using the M335R mask in the F356W and F444W filters at two roll angles separated by ~10 degrees to enable angular differential imaging to suppress the stellar PSF. We will also take advantage of the newly available simultaneous short-wave option and also observe in the F200W filter. In a unbroken sequence with the science target, we will observe a PSF reference that is well matched in temperature and magnitude using the same instrument set-up in a 9-point small grid dither pattern at one roll angle. This will allow for additional suppression of starlight by using the diversity of PSFs from the dither pattern in a reference library for reference differential imaging analyses. We will also obtain astrometric confirmation images to enable precise measurement of the absolute host star position and a common proper motion analysis to confirm that the exoplanet candidate is bound to the host star.

Proposal 3840 - Targets - JWST NIRCam Confirmation of the First Directly Imaged Sub-Saturn Mass Exoplanet

	# Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous				
	(1) 2MJ0944	RA: 09 44 54.1925 (146.2258021d)	Proper Motion RA: -331.336 mas/yr					
		Dec: -12 20 54.37 (-12.34844d)	Proper Motion Dec: 40.034 mas/yr					
		Equinox: J2000	Parallax: 0.0761746"					
			Epoch of Position: 2000	Epoch of Position: 2000				
Targets	Comments: Astrometry updated SpTy = $M5$ Age = 50 Myr Group Membership = Argus A: K_{-s} , W1, W2 = 7.60, 7.36, 7.19 Category=Star Description=[M dwarfs] Extended=NO	d with Gaia EDR3 ssociation 9						
ed	(2) V-AP-COL	RA: 06 04 52.1487 (91.2172863d)	Proper Motion RA: 25.721 mas/yr					
Ě		Dec: -34 33 35.77 (-34.55994d)	Proper Motion Dec: 342.854 mas/yr					
_		Equinox: J2000	Parallax: 0.1153997"					
			Epoch of Position: 2000					
	Comments: Astrometry updated SpTy = $M4.5$ Age = 50 Myr Group Membership = Argus As K_{-s} , $W1$, $W2 = 6.87$, 6.67 , 6.39 Category=Star Description=[M dwarfs] Extended=NO	d with Gaia EDR3 ssociation 9						

Pro	. posal 3840	Observation	1 - JWST N	RCam Confirm	nation of the	First Directl	y Imaged Sub-S	Saturn Mass E	Exoplanet	
L N	Proposal 3840, Obs	servation 1: 2MJ094	4 roll 1						Fri Dec 1	5 00:00:27 GMT 2023
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Ž	Observing Template	: NIRCam Coronagra	phic Imaging							
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١ <u></u>	(2MJ0944 roll 1 (Ob	os 1)) Informational (H	Form): The Visit Pla	nner and Spike may pro-	duce different schedu	lability results.				
Įğ	(Visit 1:1) Informati	onal (Form): Visit scl	hedulable, but most s	cheduling windows are	when JWST is point	ed in direction of g	reatest micrometeoroid im	pact risk. This is likel	y due to scheduling s	pecial requirements.
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	# Nam	e	Target Coord	inates		Targ. Coord. Cor	rections	Miscella	neous	
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	Comments: Astrome	try updated with Gaid	a EDR3							
ĕ	SpTy = M5 Age = 50 Myr									
Ē	Group Membership	= Argus Association								
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	Description = [M dwo	arfs]								
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Proposal 3840 - Observation 1 - JWST NIRCam Confirmation of the First Directly Imaged Sub-Saturn Mass Exoplanet

 V-AP-COL roll 1 (Obs 3) (PSF Reference; Filters [F200W/F356W, F200W/F444W])

 Additional Justification: false

 Sequence Observations 1, 2, 3, Non-interruptible

 Aperture PA Offset 2 from 1 by 10 to 14 Degrees (Same offsets in V3)

Pro	. posal 3840	Observation	2 - JWST N	IRCam Confirm	nation of the	First Direct	ly Imaged Sub-S	Saturn Mass B	Exoplanet	
L n	Proposal 3840, Obs	servation 2: 2MJ0944	4 roll 2						Fri Dec 1	5 00:00:27 GMT 2023
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P	# Nam	e	Target Coor	dinates		Targ Coord Co	rrections	Miscella	neous	
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			Dec: -12 20 5	4.37 (-12.34844d)		Proper Motion De	ec: 40.034 mas/yr			
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ΪË	Comments: Astrome	try updated with Gaid	a EDR3							
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le l	2	F200W	F356W	MEDIUM8	10	17	1	17	1799.542	
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Pro	oposal 3840 - Observation 2 - JWST NIRCam Confirmation of the First Directly Imaged Sub-Saturn Mass Exoplanet							
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Pro	<u>posal 3840 -</u>	Observation	<u>3 - JWST NIE</u>	<u>RCam Confirm</u>	nation of the	First Directly I	maged Sub-S	<u>Saturn Mass E</u>	<u>-xoplanet</u>	
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lμ	2	F200W	F356W	MEDIUM8	10	2	9	18	1905.398	
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Pro	posal 3840 - Observation 3 - JWST NIRCam Confirmation of the First Directly Imaged Sub-Saturn Mass Exoplanet
PSF References	PSF Reference: true
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