

# 2084 - Is it raining lava in the evening on 55 Cancri e?

Cycle: 1, Proposal Category: GO

### **INVESTIGATORS**

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## **OBSERVATIONS**

Folder	Observation	Label	Observing Template	Science Target
Observa	ation Folder			
	1	Even occultation	NIRCam Grism Time Series	(1) 55CNC
	2	Odd occultation	NIRCam Grism Time Series	(1) 55CNC
	3	Even occultation	NIRCam Grism Time Series	(1) 55CNC
	4	Odd occultation	NIRCam Grism Time Series	(1) 55CNC

JWST Proposal 2084 (Created: Tuesday, November 29, 2022 at 6:01:59 PM Eastern Standard Time) - Overview

Folder	Observation	Label	Observing Template	Science Target
	5	Repeat Obs 4 - Odd occultation	NIRCam Grism Time Series	(1) 55CNC

#### **ABSTRACT**

The nearby hot super-Earth planet 55 Cancri e shows variable occultation depths, i.e. variable amounts of dayside emission. The origin of these variations could lie in several phenomena, intrinsically dependent on the planetary atmospheric properties or surface features. We aim to identify the origin of this variation, and specifically test whether it originates from different sides of the planet being visible due to a 3:2 spin-orbit resonance. Even for an atmosphereless "bare rock", this asynchronous rotation would produce a magma pool and mineral vapors over the day side that depend on the local surface conditions, giving rise to variability. If the surface is dominated by silicates, as is likely for a hot rocky planet, the extreme temperatures of the day side would produce detectable amounts of SiO gas from the vaporization of SiO2 in the morning that subsequently rains out and recrystallizes back to SiO2 in the evening. If the planet is in a 3:2 spin-orbit resonance, every second occultation would show the same face of the planet with the emission highly correlated. The planet could also be covered by a massive atmosphere that provides the thermal inertia, even in the case that the variability is unrelated to asynchronous rotation, to explain the observed redistribution of heat. Spectral features, potentially variable, may then be detected. We thus aim to answer the following questions: 1) Is there a massive atmosphere or is it essentially a bare rock with vaporized SiO? 2) If a bare rock, can the variability be explained by asynchronous rotation? This will help us understand the origin and nature of hot super-Earths, of which 55 Cnc e is the best representative.

#### **OBSERVING DESCRIPTION**

We propose to observe four occultations of the hot super-Earth 55 Cancri e using a grism time series with NIRCam+F444W. This is the only mode that is not saturated by this very bright naked-eye star.

Since we want to test the hypothesis that the planet shows alternate sides between each occultation, we put time constraints to observe 2 ``even" occultations and 2 ``odd", so that both sides of the planet get observed. Moreover, since the surface features can be expected to only be semi-stable, we want to observe all occultations close in time, within two weeks to avoid the surface changing too much. Hence we put additional constraints on the time between the first and last visit. This should not be too difficult to schedule since the orbital period is only 0.74 days.

## Proposal 2084 - Targets - Is it raining lava in the evening on 55 Cancri e?

	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous		
l o	(1)	55CNC	RA: 08 52 35.2410 (133.1468375d)	Proper Motion RA: -0.03679884480833323 sec of			
get			Dec: +28 19 47.34 (28.32982d)	time/yr			
			Equinox: J2000	Proper Motion Dec: -0.2336509999622649 arcsec/yr			
] <sub>a</sub>			Equilion. \$2000	Parallax: 0.079"			
р				Epoch of Position: 2015.5			
	Comments: Category=S		targetselector and retrieved from the SIMBAD database.				
	Description=[Exoplanet Systems, Exoplanets, G subdwarfs]						
	Extended= $N$	IO .					

Observation	Proposal 2084 - Observation Proposal 2084, Observation 1: Even occ Diagnostic Status: Warning Observing Template: NIRCam Grism Tim Comments: Acquisition S/N ~ 350 The defined period for the phase constrain There is a bright nearby (4.2') star 53 Cne	ultation e Series t is twice the orbital p	period in order to dis	stinguish between ever		s (at phase 0.25 and 0.7.	5, respectively, while t		29 23:01:59 GMT 2022 uses 0 and 0.5).
Diagnostics	(Even occultation (Obs 1)) Warning (Form (Visit 1:1) Warning (Form): Data Excess (Visit 1:1) Warning (Form): Overheads are	over lower threshold			ove this limit it is pos	sible that a High Gain A	antenna move may occ	ur during the exposur	e.
Fixed Targets	# Name (1) 55CNC  Comments: This object was generated by a Category=Star	Dec: +28 19 47. Equinox: J2000	·10 (133.1468375d) 34 (28.32982d)	IMBAD database.	time/yr	-0.03679884480833323 -0.2336509999622649		neous	
quisition	Description=[Exoplanet Systems, Exoplan Extended=NO  # Target  1 SAME	subarray SUB32TATSGRIS	Filter F405N+F444W	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID

	Description=[Exople Extended=NO	anet Systems, Exoplan	nets, G subdwarfs]							
tion	#	Target	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	<b>Total Integrations</b>	Total Exposure Time	ETC Wkbk.Calc ID
Acquisition	1	SAME	SUB32TATSGRIS M	F405N+F444W	RAPID	3	1	1	0.062	63816
te	Subarray					No. of Output Cha	nnels			
Template	SUBGRISM64					4				
nts	#	Short Pupil+Filter	Long Pupil+Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	<b>Total Integrations</b>	Total Exposure Time	ETC Wkbk.Calc ID
Spectral Elements	1	CLEAR+WLP4	GRISMR+F444W	RAPID	2	16100	1	16100	16533.895	63429

<u>Pro</u>	oposai 2084 - Observation 1 - is it raining lava in the evening on 55 Cancri e?
ments	Phase 0.17041 to 0.19897 with period 1.47308920 Days and zero-phase 2458932.56274 HJD Time Series Observation No Parallel Attachments Group Observations 1, 2, 3, 4 within 14 Days
Require	Group Observations 1, 2, 3, 4 within 14 Days
Special F	

	posal 2084 - Observa Proposal 2084, Observation 2: O	dd occultation		Tue Nov 29 23:01:59 GMT 202							
vation	Diagnostic Status: Warning										
/at	Observing Template: NIRCam Grism Time Series										
	Comments: Acquisition S/N ~ 350										
Obser	The defined period for the phase co	onstraint is twice the orbital period in order to distinguish b	etween even and odd occultations (at phase 0.25 and 0.7)	5, respectively, while transits happen at phases 0 and 0.5).							
	There is a bright nearby (4.2') star	53 Cnc, but it is separated enough to not contaminate our cont	data.								
SS	(Odd occultation (Obs 2)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.										
stics	(Visit 2:1) Warning (Form): Data E	Excess over lower threshold									
gnosti		Excess over lower threshold eads are provisional until the Visit Planner has been run.									
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Diagnosti			Targ. Coord. Corrections	Miscellaneous							
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Diagno	(Visit 2:1) Warning (Form): Overh  # Name	eads are provisional until the Visit Planner has been run.  Target Coordinates	Proper Motion RA: -0.03679884480833323 time/yr	sec of							
Targets Diagnosti	(Visit 2:1) Warning (Form): Overh  # Name	Target Coordinates RA: 08 52 35.2410 (133.1468375d)	Proper Motion RA: -0.03679884480833323	sec of							

quisition	#	Target	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calo
	1	SAME	SUB32TATSGRIS M	F405N+F444W	RAPID	3	1	1	0.062	63816
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	#	Short Pupil+Filter	Long Pupil+Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	<b>Total Integrations</b>	Total Exposure Time	ETC Wkbk.Ca
	1	CLEAR+WLP4	GRISMR+F444W	RAPID	2	16100	1	16100	16533.895	63429

Epoch of Position: 2015.5

<u> </u>	oposai 2084 - Observation 2 - is it raining lava in the evening on 55 Cancri e?
ments	Phase 0.67041 to 0.69897 with period 1.47308920 Days and zero-phase 2458932.56274 HJD Time Series Observation No Parallel Attachments
Require	Group Observations 1, 2, 3, 4 within 14 Days
Special	

Pro	oposal 2084 -	Observation	3 - Is it rainin	g lava in the	evening on 5	5 Cancri e?						
	i e	servation 3: Even occ			• •				Tue Nov 2	29 23:01:59 GMT 2022		
<u> </u>	Diagnostic Status: Warning											
/ati	Observing Template	e: NIRCam Grism Tim	e Series									
ē	Comments: Acquisit	tion S/N ~ 350										
Observation	The defined period for the phase constraint is twice the orbital period in order to distinguish between even and odd occultations (at phase 0.25 and 0.75, respectively, while transits happen at phases 0 and 0.5).											
<u> </u>	There is a bright nearby (4.2') star 53 Cnc, but it is separated enough to not contaminate our data.											
is l	(Even occultation (Obs 3)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.  (Visit 3:1) Warning (Form): Data Excess over lower threshold											
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Diagnostics												
۴	# Nam	e	Target Coordin	ates		Targ. Coord. Correc	tions	Miscella	neous			
٨	(1) 550			10 (133.1468375d)		Proper Motion RA: -0						
Jet 1			Dec: +28 19 47.3	34 (28.32982d)		time/yr						
arç I			Equinox: J2000			Proper Motion Dec: -0.2336509999622649 arcsec/yr						
						Parallax: 0.079"						
Fixed Targets	Community This als		d		MDAD database	Epoch of Position: 20	15.5					
i	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Category=Star											
	Description=[Exop: Extended=NO	lanet Systems, Exoplar	iets, G subdwarfs]									
Acquisition	#	Target	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	<b>Total Integrations</b>	Total Exposure Time	ETC Wkbk.Calc ID		
isi	1	SAME	SUB32TATSGRIS	F405N+F444W	RAPID	3	1	1	0.062	63816		
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١٤	1	CLEAR+WLP4	GRISMR+F444W	RAPID	2	16100	1	16100	16533.895	63429		
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<u> </u>	oposai 2084 - Observation 3 - is it raining lava in the evening on 55 Cancri e?
ments	Phase 0.17041 to 0.19897 with period 1.47308920 Days and zero-phase 2458932.56274 HJD Time Series Observation No Parallel Attachments
Require	Group Observations 1, 2, 3, 4 within 14 Days
Special	

Pr	oposal 208	4 - Observation	4 - Is it rainin	g lava in the	evening on 5	5 Cancri e?					
		Proposal 2084, Observation 4: Odd occultation  Tue Nov 29 23:01:59 GMT									
<u> </u>	Diagnostic Stat	us: Warning									
ati	Observing Temp	olate: NIRCam Grism Tin	ne Series								
ē	Comments: Acq	uisition S/N ~ 350									
Observation	The defined period for the phase constraint is twice the orbital period in order to distinguish between even and odd occultations (at phase 0.25 and 0.75, respectively, while transits happen at phases 0 and 0.5).										
There is a bright nearby (4.2') star 53 Cnc, but it is separated enough to not contaminate our data.											
(Odd occultation (Obs 4)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure (Visit 4:1) Warning (Form): Data Excess over lower threshold (Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									b.		
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ig l	Dec: +28 19 47.34 (28.32982d)					time/yr					
arg	Equinox: J2000					Proper Motion Dec: -0.2336509999622649 arcsec/yr					
ΙË	·					Parallax: 0.079"					
Ιĕ	<u>w</u>					Epoch of Position: 2015.5					
iÊ	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.  Category=Star										
Description=[Exoplanet Systems, Exoplanets, G subdwarfs]  Extended=NO											
Acquisition		Target	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	<b>Total Integrations</b>	Total Exposure Time	ETC Wkbk.Calc ID	
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<u> </u>	oposai 2084 - Observation 4 - is it raining lava in the evening on 55 Cancri e?
ments	Phase 0.67041 to 0.69897 with period 1.47308920 Days and zero-phase 2458932.56274 HJD Time Series Observation No Parallel Attachments
Require	Group Observations 1, 2, 3, 4 within 14 Days
Special	

		<u>ition 5 - Is it rainin</u>	g iava iii tiic	everning on 3	<u> 5 Cantin e :</u>								
_	Proposal 2084, Observation 5: Re							Tue Nov 2	29 23:01:59 GMT 2022				
1.፬	Diagnostic Status: Warning												
/ati	Observing Template: NIRCam Gri	sm Time Series											
e l	Comments: Acquisition S/N ~ 350												
Observation	The defined period for the phase constraint is twice the orbital period in order to distinguish between even and odd occultations (at phase 0.25 and 0.75, respectively, while transits happen at phases 0 and 0.5).												
L.		here is a bright nearby (4.2') star 53 Cnc, but it is separated enough to not contaminate our data.											
<u>  S</u>	(Repeat Obs 4 - Odd occultation (C		osure Duration exce	eds the limit of 10000.	0 seconds. Above the	his limit it is possible that	a High Gain Antenna	move may occur dur	ing the exposure.				
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<u>a</u> j	<b>[</b> ]												
	# Name	Target Coordin			Targ. Coord. Cor		Miscella	neous					
ţ	(1) 55CNC RA: 08 52 35.2		10 (133.1468375d)		Proper Motion RA: -0.03679884480833323 sec of time/vr								
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1 5			34 (28.32982d)			c: -0.2336509999622649	arcsec/yr						
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ixed Targ	Comments: This object was genera	Equinox: J2000	,	IMBAD database.	Proper Motion De Parallax: 0.079"		arcsec/yr						
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Fixed	Comments: This object was general Category=Star Description=[Exoplanet Systems, Extended=NO	Equinox: J2000  sted by the targetselector and  Exoplanets, G subdwarfs]  Subarray	retrieved from the S	Readout Pattern	Proper Motion De Parallax: 0.079" Epoch of Position: Groups/Int	Integrations/Exp	Total Integrations	Time	ID				
Acquisition Fixed Targ	Comments: This object was general Category=Star Description=[Exoplanet Systems, Extended=NO	Equinox: J2000  sted by the targetselector and Exoplanets, G subdwarfs]  Subarray  SUB32TATSGRIS	retrieved from the S	Readout Pattern	Proper Motion De Parallax: 0.079" Epoch of Position: Groups/Int	Integrations/Exp	Total Integrations	Time	ID				
Acquisition Fixed	Comments: This object was general Category=Star Description=[Exoplanet Systems, International Extended=NO]  # Target  1 SAME	Equinox: J2000  sted by the targetselector and Exoplanets, G subdwarfs]  Subarray  SUB32TATSGRIS	retrieved from the S	Readout Pattern	Proper Motion De Parallax: 0.079" Epoch of Position: Groups/Int	Integrations/Exp	Total Integrations	Time	ID				
Acquisition Fixed	Comments: This object was general Category=Star Description=[Exoplanet Systems, International Extended=NO]  # Target  1 SAME	Equinox: J2000  sted by the targetselector and Exoplanets, G subdwarfs]  Subarray  SUB32TATSGRIS	retrieved from the S	Readout Pattern	Proper Motion De Parallax: 0.079" Epoch of Position: Groups/Int	Integrations/Exp	Total Integrations	Time	ID				
Acquisition Fixed	Comments: This object was general Category=Star Description=[Exoplanet Systems, International Extended=NO]  # Target  1 SAME	Equinox: J2000  sted by the targetselector and Exoplanets, G subdwarfs]  Subarray  SUB32TATSGRIS	retrieved from the S	Readout Pattern	Proper Motion De Parallax: 0.079" Epoch of Position:  Groups/Int  3	Integrations/Exp	Total Integrations	Time	ID				
Fixed	Comments: This object was general Category=Star Description=[Exoplanet Systems, International Extended=NO]  # Target  1 SAME	Equinox: J2000  sted by the targetselector and Exoplanets, G subdwarfs]  Subarray  SUB32TATSGRIS	retrieved from the S	Readout Pattern	Proper Motion De Parallax: 0.079" Epoch of Position:  Groups/Int  3	Integrations/Exp	Total Integrations	Time	ID				

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ents	#	Short Pupil+Filter	Long Pupil+Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	<b>Total Integrations</b>	Total Exposure Time	ETC Wkbk.Calc ID
Eleme	1	CLEAR+WLP4	GRISMR+F444W	RAPID	2	16100	1	16100	16533.895	63429
ctral										

<u> Pr</u>	oposai 2084 - Observation 5 - is it raining iava in the evening on 55 Cancri e?
Requirer	Phase 0.67041 to 0.69897 with period 1.47308920 Days and zero-phase 2458932.56274 HJD Time Series Observation No Parallel Attachments
Special	