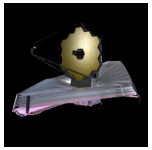

5342 - Spectroscopic characterization of the lowest-mass imaged Jupiter analog

Cycle: 3, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
Mr. Jerry Xuan (PI)	**California Institute of Technology**
Dr. Jean-Baptiste Ruffio (CoI) (CoPI)	University of California - San Diego
Dr. Yapeng Zhang (CoI) (CoPI)	California Institute of Technology
Dr. Dimitri Mawet (CoI)	California Institute of Technology
Dr. Heather A. Knutson (CoI)	California Institute of Technology
Dr. Jason J. Wang (CoI)	Northwestern University
Dr. Eric Nielsen (CoI)	New Mexico State University
Dr. Robert J De Rosa (CoI) (ESA Member)	European Southern Observatory - Chile
William Balmer (CoI)	Space Telescope Science Institute
Dr. Laurent Pueyo (CoI)	Space Telescope Science Institute
Mr. Aniket Sanghi (CoI)	California Institute of Technology
Dr. Bruce A. Macintosh (CoI)	University of California - Santa Cruz
Dr. Nicole L. Wallack (CoI)	Carnegie Institution of Washington
Dr. Brendan Bowler (CoI)	University of Texas at Austin
Kyle Franson (CoI)	University of Texas at Austin
Julie Inglis (CoI)	California Institute of Technology

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	AFLepb	NIRSpec IFU Spectroscopy	(1) AF-Lep-b

ABSTRACT

We propose to collect NIRSpec high-resolution spectroscopy (R~2700, 2.9-5.3 micron) for AF Lep b, the lowest-mass directly imaged planet with a dynamical mass (3 Jupiter masses). Orbiting its late-F host star with a semi-major axis of 8 AU, AF Lep b is one of the closest analogs to Jupiter amenable to spectral characterization with JWST. Our program will measure the abundances of at least five different molecules (CH4, H2O, H2S, CO2, CO) to provide a comprehensive picture of AF Lep b's atmosphere. Specifically, our simultaneous constraints on C/H, O/H, and S/H would break degeneracies in the planet's formation location relative to various snowlines by constraining the solid-to-gas accretion rate. In addition, we will measure the vertical mixing coefficient to high precision from carbon disequilibrium chemistry, which has important implications for cloud formation and the spectral appearance of cool planets. Finally, our program will enable a comparative atmospheric study with another Jupiter analog in the same beta Pic moving group, 51 Eri b, to be observed by GO 3552 with NIRSpec. 51 Eri b has similar model-inferred mass and semi-major axis as AF Lep b, but is a factor of about 3 fainter than AF Lep b at 2 and 4 microns. Do the two planets have similar elemental abundances, indicating similar formation pathways? Or could differences in their abundances shed light on different formation timescales, even different formation mechanisms? Our program would inform planet formation in a region of parameter space where giant planets are most common (~1-10 AU).

OBSERVING DESCRIPTION

We propose to use the NIRSpec 200 mas wide fixed slit (S200A2) with the 2.87-5.27 micron filter (F290LP) at moderate resolution (G395H; R~2,700) to measure elemental abundances of AF Lep b. The planet will be ~300 mas away from the star so we require the slit to be oriented perpendicular to the planet-star axis to avoid saturation. The science observation will be dominated by the light from the stellar halo and therefore requires a reference observation of the speckle field on the other side of the star. Using proven techniques from Cycle 1 NIRSpec data, the reference spectra will be used to subtract the stellar light in the science data that includes the planet signal. The host star (AF Lep) is too bright for target acquisition, so a Gaia offset star ~30 arcsec away from AF Lep will be used.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	AF-Lep-b	RA: 05 27 4.7827 (81.7699279d) Dec: -11 54 3.47 (-11.90096d) Equinox: J2000	Proper Motion RA: 16.915 mas/yr Proper Motion Dec: -49.318 mas/yr Parallax: 0.0372539" Epoch of Position: 2000.0	
Comments: Position of the planet (not the star), which is 0.29 arcsec East of the host star. The stellar position was retrieved from Gaia DR3 and the offset of the planet is from the latest orbit fit. Category=Star Description=[Exoplanets] Extended=NO				
(2)	Offset-star	RA: 05 27 6.8205 (81.7784188d) Dec: -11 54 9.63 (-11.90267d) Equinox: J2000	Proper Motion RA: 8.566 mas/yr Proper Motion Dec: -7.754 mas/yr Parallax: 0.0004065" Epoch of Position: 2000.0	
Comments: This is the offset star for target acquisition. We used the J2000 coordinates from the Vizier table for Gaia DR3, hence the epoch is 2000.0. Category=Star Description=[K dwarfs] Extended=NO				

Observation

Proposal 5342, Observation 1: AFLepb

Tue Sep 03 20:00:48 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Comments: It is important to schedule this observation as close to V3PA=41.5 deg as possible. V3PA=41.5 deg is the ideal angle which keeps the planet-star line orthogonal to the IFU slicers. This helps minimize the risk of speckles from the star saturating at the planet location, which is key to the science goals.
If there is flexibility please prioritize scheduling our program closer to 41.5 deg rather than at either edges of the required window.

Diagnostics

(Visit 1:1) Warning (Form): Data Excess over lower threshold

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	AF-Lep-b	RA: 05 27 4.7827 (81.7699279d)	Proper Motion RA: 16.915 mas/yr	
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			Epoch of Position: 2000.0	

Comments: Position of the planet (not the star), which is 0.29 arcsec East of the host star.
The stellar position was retrieved from Gaia DR3 and the offset of the planet is from the latest orbit fit.
Category=Star
Description=[Exoplanets]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	2 Offset-star	WATA	SUB2048	F110W	NRSRAPID	3	1	1	3.628	213369.9

Mosaic

Rows	Columns	Row Overlap %	Column Overlap %	Row shift (deg)	Column shift (deg)	Tile Order
1	2	10.0	50.0	0.0	0.0	DEFAULT

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	MEDIUM	1	20	

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	NRSRAPID	4	16	false	true	NONE	20	320	17178.832	

Special Requirements	Aperture PA Range 170.47164917 to 190.47164917 Degrees (V3 31.5 to 51.5)