



14462 - Hydrogen Escape from an Earth-size Exoplanet: a Reconnaissance Study

Cycle: 23, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
Dr. Zachory K. Berta-Thompson (PI) (Contact)	Massachusetts Institute of Technology	zkbt@mit.edu
Prof. David Charbonneau (CoI) (AdminUSPI)	Harvard University	dcharbonneau@cfa.harvard.edu
Dr. Jonathan Irwin (CoI)	Harvard University	jirwin@cfa.harvard.edu
Ms. Elisabeth R. Newton (CoI)	Harvard University	enewton@cfa.harvard.edu
Mr. Jason A. Dittmann (CoI)	Harvard University	jdittmann@cfa.harvard.edu
Dr. Vincent Bourrier (CoI) (ESA Member)	Observatoire de Geneve	bourrier@iap.fr
Dr. David Ehrenreich (CoI) (ESA Member)	Observatoire de Geneve	david.ehrenreich@unige.ch

VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) LHS-281 WAVE	STIS/CCD STIS/FUV-MAMA	1	12-Dec-2015 21:02:02.0	yes
02	(1) LHS-281 WAVE	STIS/CCD STIS/FUV-MAMA	1	12-Dec-2015 21:02:04.0	yes

2 Total Orbits Used

ABSTRACT

We just found a small (1.2 Earth radius), warm (roughly 500K) exoplanet transiting a small, nearby M dwarf star. The system's proximity and large planet-to-star radius ratio make it an ideal laboratory for studying the evolution of terrestrial planet atmospheres around M dwarfs, a topic that is important for understanding the habitability of planets around such stars. Depending on how much hydrogen or water is currently being lost from its

atmosphere, this new planet might be surrounded by a giant neutral hydrogen exosphere. We would like to measure the size of this cloud, by observing its transit at Lyman-alpha wavelengths with STIS. However, large uncertainties in the strength of the star's Lyman-alpha emission and qualitative depth of the expected transit make it difficult to plan an efficient Hubble program to make such measurements. Here, we propose a two-orbit reconnaissance study to determine how Hubble's precious UV capabilities can be optimally employed to observe this important exoplanet system in Cycle 24. It is possible the planet's exosphere makes a total eclipse of the star at Lyman-alpha; this two-orbit program could detect such an eclipse, which would be the first observation of the exosphere of an Earth-size exoplanet.

OBSERVING DESCRIPTION

With this program, we will observe the rocky exoplanet host GJ 1132 with STIS/G140M at Lyman-alpha wavelengths. We want to (a) measure how bright the star is at Lyman-alpha and (b) assess whether escaping gas from the planet is causing very deep Lyman-alpha eclipses of the star. The goal of this mid-Cycle program is to answer these questions before the proposal deadline for Cycle 24 -- we have included timing requirements on the visits to meet this goal.

We will gather one visit far from the time of the planet GJ1132b's transit. With this observation, we hope to measure the strength of the star's Lyman-alpha line.

Our nominal plan is to gather the second visit during GJ1132b's transit. If the planet is surrounded by a giant cloud of neutral hydrogen, we could see up to a 100% eclipse. However, there is a possibility that the star will be detected very faintly in the first out-of-transit observation or not at all. If so, the eclipse observation would be less meaningful, and we would prefer that the second visit **also** be scheduled far from times of transit.

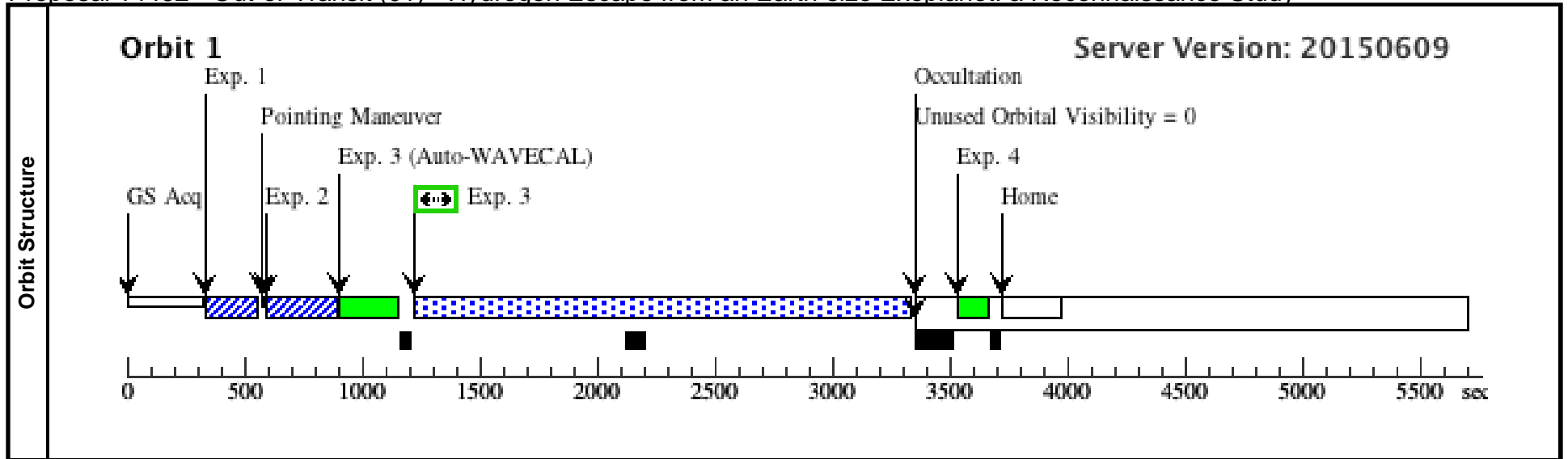
According to the Visit Planner, the timing restrictions required to make this possible basically require that the first visit occur in January and the second in March. If this proves too limiting, then our preferred course of action would be (first) to relax the PHASE constraint on the in-transit orbit, to allow it to extend a bit beyond the optical transit and (second) to schedule the orbits regardless of order, in order to meet the Cycle 24 deadline.

The instrument settings are similar to those in GO14222 and GO 12965. We opt for the nominal 52X0.05 aperture instead of the low-dark-current 52X0.05D1 aperture, because we are more concerned about geocoronal sky subtraction than we are about dark current. We request an additional GO-WAVECAL after the conclusion of the science observation, during Earth-occultation.

Proposal 14462 - Out-of-Transit (01) - Hydrogen Escape from an Earth-size Exoplanet: a Reconnaissance Study

Sun Dec 13 02:02:05 GMT 2015

Visit	Proposal 14462, Out-of-Transit (01), implementation Diagnostic Status: No Diagnostics Scientific Instruments: STIS/CCD, STIS/FUV-MAMA Special Requirements: Period 1.628930 D AND ZERO-PHASE HJD2457184.55786 <i>Comments: This visit must be obtained far from a time of transit, to provide a clean estimate of the baseline UV flux from the star. Experience from G1436 suggests that, in an extreme case, it might be possible for Ly-alpha to be absorbed from the phase of transit all the way to anti-transit. We specify PHASE constraints limited this "out-of-transit" orbit be obtained between phases 0.5 and 0.8.</i>										
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
(1)		LHS-281 Alt Name1: GJ1132	RA: 10 14 51.7700 (153.7157083d) Dec: -47 09 24.10 (-47.15669d) Equinox: J2000	Proper Motion RA: -1046 mas/yr Proper Motion Dec: +416 mas/yr Parallax: 0.08307" Epoch of Position: 2000.0 Radial Velocity: +35 km/sec	V=13.49+/-0.03 U=16.51, B=15.17, V=13.49, Rc=12.26, Ic=10.69, J=9.245, H=8.666, Ks=8.322	Reference Frame: ICRS					
<i>Comments: RA, Dec, proper motions, parallax were drawn from RECONS astrometry originally published in Jao et al. (2005; 2005AJ...129.1954J) and restated in Berta-Thompson et al. (2015; 2015Natur.527..204B). We adopt uncertainties on the RA and Dec as those for 2MASS for this object, through which these positions are tied to the ICRS. The RECONS astrometry is more accurate than the positions and proper motions listed in SIMBAD. We confirmed that the quoted position and proper motions match both the epoch 1992 position of the star in the APT Target Confirmation Chart and the epoch 2015.8 position of the star in recent MEarth imaging. Extended=NO</i>											
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
	1	ACQ (STIS.ta.756 590)	(1) LHS-281	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT	PHASE 0.5 TO 0.78	Sequence 1-4 Non-Int in Out-of-Transit (0 1)	0.2 Secs (0.2 Secs) [==>]	[1]	
	<i>Comments: We use the F28X50LP filter for this ACQ image, to ensure the brightness is weighted most strongly toward red wavelengths, where the target star is brightest. Due to its proper motion, the target is approaching a nearby star (about 1" away and 4.7 magnitudes fainter in R-band). While we don't know the spectrum of this faint star, we can guarantee that in the long-pass filter, GJ1132 will be much brighter than this star. The ETC quotes a time to saturation of 2.83s for the F28X50LP filter, and a time of 0.0152s to reach S/N=40. Our 0.2s exposure time for the ACQ should reach 7% of saturation.</i>										
	2	ACQ/PEAK (STIS.ta.757 054)	(1) LHS-281	STIS/CCD, ACQ/PEAK, 52X0.05	MIRROR				Sequence 1-4 Non-Int in Out-of-Transit (0 1)	1.0 Secs (1 Secs) [==>]	[1]
	<i>Comments: The ETC lists a time to saturation through the 52X0.05 slit of 6.30s and a count rate of 100965e/s. With our 1.0s exposure, we should reach 100,000 source electrons, above the 80,000 required for peak-up but still well below saturation.</i>										
3	SCIENCE (STIS.sp.75 6606)	(1) LHS-281	STIS/FUV-MAMA, TIME-TAG, 52X0.05	G140M 1222 A		BUFFER-TIME=90 0		Sequence 1-4 Non-Int in Out-of-Transit (0 1)	2095 Secs (2095 Secs) [==>]	[1]	
<i>Comments: We use the same buffer time as GO12965, because we expect GJ1132 will be fainter than G1436 at these wavelengths.</i>											
4	GO-WAVE CAL	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.05	G140M 1222 A				Sequence 1-4 Non-Int in Out-of-Transit (0 1)	82 Secs (82 Secs) [==>]	[1]	
<i>Comments: We request an additional GO-WAVECAL be taken after the completion of the orbit, during Earth occultation. We will use this together with the AUTO-WAVECAL to check for drifts in the wavelength calibration over our orbit. We set the exposure time to be the same as for the AUTO-WAVECAL.</i>											



Proposal 14462 - In-Transit (02) - Hydrogen Escape from an Earth-size Exoplanet: a Reconnaissance Study

Sun Dec 13 02:02:05 GMT 2015

Visit	Proposal 14462, In-Transit (02), implementation									
	Diagnostic Status: No Diagnostics									
Fixed Targets	Scientific Instruments: STIS/CCD, STIS/FUV-MAMA									
	Special Requirements: AFTER 01 BY 30 D TO 60 D; BEFORE 05-APR-2016:00:00:00; Period 1.628930 D AND ZERO-PHASE HJD2457184.55786									
<p><i>Comments: If the star is bright at Ly-alpha wavelengths, then this visit should be scheduled during a transit of the planet GJ1132b. We have scheduled this orbit to follow after the out-of-transit orbit with the hope that we could potentially nudge the scheduling of this visit based on a quick look at the Visit 01 data. If we see the star is bright, we continue with the plan to gather this second orbit in transit. If we see the star is faint (i.e. undetected or only barely detected at Ly-alpha), then we would strongly prefer that this second visit *not* be scheduled during transit. That way, we could get a deeper limit (or detection) of the intrinsic stellar Ly-alpha line.</i></p>										
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous					
(1)	LHS-281	RA: 10 14 51.7700 (153.7157083d)	Proper Motion RA: -1046 mas/yr	V=13.49+/-0.03	Reference Frame: ICRS					
	Alt Name1: GJ1132	Dec: -47 09 24.10 (-47.15669d)	Proper Motion Dec: +416 mas/yr	U=16.51,						
		Equinox: J2000	Parallax: 0.08307"	B=15.17,						
			Epoch of Position: 2000.0	V=13.49,						
			Radial Velocity: +35 km/sec	Rc=12.26,						
				Ic=10.69,						
				J=9.245,						
				H=8.666,						
				Ks=8.322						
<p><i>Comments: RA, Dec, proper motions, parallax were drawn from RECONS astrometry originally published in Jao et al. (2005; 2005AJ....129.1954J) and restated in Berta-Thompson et al. (2015; 2015Natur.527..204B). We adopt uncertainties on the RA and Dec as those for 2MASS for this object, through which these positions are tied to the ICRS. The RECONS astrometry is more accurate than the positions and proper motions listed in SIMBAD. We confirmed that the quoted position and proper motions match both the epoch 1992 position of the star in the APT Target Confirmation Chart and the epoch 2015.8 position of the star in recent MEarth imaging. Extended=NO</i></p>										
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
1	ACQ (STIS.ta.756590)	(1) LHS-281	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT	PHASE 0.9836 TO 0.9951	Sequence 1-4 Non-Int in In-Transit (02)	0.2 Secs (0.2 Secs)	[==>]	[1]
<p><i>Comments: We use the F28X50LP filter for this ACQ image, to ensure the brightness is weighted most strongly toward red wavelengths, where the target star is brightest. Due to its proper motion, the target is approaching a nearby star (about 1" away and 4.7 magnitudes fainter in R-band). While we don't know the spectrum of this faint star, we can guarantee that in the long-pass filter, GJ1132 will be much brighter than this star. The ETC quotes a time to saturation of 2.83s for the F28X50LP filter, and a time of 0.0152s to reach S/N=40. Our 0.2s exposure time for the ACQ should reach 7% of saturation.</i></p>										
<p><i>PHASE constraints are set so the UV exposure starts sometime between the start of ingress and 20 minutes before the end of egress. If necessary to schedule this observation, this phase constraint could be relaxed.</i></p>										
2	ACQ/PEAK (STIS.ta.757054)	(1) LHS-281	STIS/CCD, ACQ/PEAK, 52X0.05	MIRROR			Sequence 1-4 Non-Int in In-Transit (02)	1.0 Secs (1 Secs)	[==>]	[1]
<p><i>Comments: The ETC lists a time to saturation through the 52X0.05 slit of 6.30s and a count rate of 100965e/s. With our 1.0s exposure, we should reach 100,000 source electrons, above the 80,000 required for peak-up but still well below saturation.</i></p>										
3	SCIENCE (STIS.sp.756606)	(1) LHS-281	STIS/FUV-MAMA, TIME-TAG, 52X0.05	G140M 1222 A	BUFFER-TIME=90 0		Sequence 1-4 Non-Int in In-Transit (02)	2095 Secs (2095 Secs)	[==>]	[1]
<p><i>Comments: We use the same buffer time as GO12965, because we expect GJ1132 will be fainter than G1436 at these wavelengths.</i></p>										
4	GO-WAVE CAL	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.05	G140M 1222 A			Sequence 1-4 Non-Int in In-Transit (02)	82 Secs (82 Secs)	[==>]	[1]
<p><i>Comments: We request an additional GO-WAVECAL be taken after the completion of the orbit, during Earth occultation. We will use this together with the AUTO-WAVECAL to check for drifts in the wavelength calibration over our orbit. We set the exposure time to be the same as for the AUTO-WAVECAL.</i></p>										

