

14860 - The most detailed high-energy picture of Proxima Centauri, our nearest

extrasolar neighbor

Cycle: 24, Proposal Category: GO/DD (Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	Targets used in Visit	Configurations used in Visit	Orbits Used	Last Orbit Planner Run	OP Current with Visit?
01	(1) V-V645-CEN	STIS/CCD STIS/FUV-MAMA	4	10-May-2017 21:05:15.0	yes
02	(1) V-V645-CEN	STIS/CCD	1	10-May-2017 21:05:18.0	yes

5 Total Orbits Used

ABSTRACT

Proposal 14860 (STScI Edit Number: 2, Created: Wednesday, May 10, 2017 8:05:19 PM EST) - Overview

Proxima Centauri b is the nearest exoplanet to the Sun. It orbits an M5.5 dwarf and is potentially habitable. The latter statement, however, depends sensitively on the high-energy irradiation on the planet. Ribas et al. (2016) estimated the high-energy flux of the host star by collecting archival data from the X-ray to the FUV regime, but explicitly state that one "unavoidable complication of estimating XUV fluxes is [...] intrinsic [stellar] variability". Here, we propose to greatly improve upon this "unavoidable complication" by obtaining simultaneous X-ray and UV observations to measure a high-resolution irradiation spectrum and, thus, to assess the habitability of Proxima b.

Our upcoming, very deep Chandra grating observation of Proxima Cen (175 ks, LETGS, PI: P. Predehl) provides a great opportunity to obtain simultaneous coverage at X-ray and UV wavelengths, i.e., to measure most of the stellar high-energy flux in a coherent way. The reason for proposing a HST DDT is that the Chandra observation is a GTO and, thus, could not be augmented by simultaneous HST observations directly as we would have proposed for in a regular GO.

Combining Chandra X-ray and HST UV data allows us to reconstruct a high-resolution spectral energy distribution (SED) including the EUV regime and, thus, a reference irradiation spectrum using the methods developed by us for the MUSCLES project.

OBSERVING DESCRIPTION

Our observing strategy is inspired by our experience from the MUSCLES project and modified to obtain a broad number of lines simultaneous with Chandra by using the STIS E140M grating instead of switching between COS G130M and G160M. The total exposure time of the Chandra observation (175 ks) will be split into two up to a few sub-exposures and we propose that HST covers one of these observations with simultaneous UV data.

We will use STIS to cover the FUV range and to resolve individual lines. Similar to the MUSCLES observations, we will append a STIS G230LB exposure to cover the wavelength range beyond ~2000 Angstrom, which allows us to cover the NUV continuum, Fe II lines at 2400 and 2600 Angstrom, and Mg II lines at 2800 Angstrom. Lastly, a short optical observation with the STIS G430L grating will calibrate the UV data to visible/IR photospheric models.

We will use the photon-counting mode to relate line fluxes (and consequently chromospheric plasma) with X-ray fluxes. Employing this strategy in APT, we find that Proxima Cen has several observing windows in May/early June2017 that allow simultaneous scheduling with Chandra. Details of

Proposal 14860 (STScI Edit Number: 2, Created: Wednesday, May 10, 2017 8:05:19 PM EST) - Overview the Chandra observation are: ObsID 19708, PropNo 18200754.

Detector safety:

We follow ISR STIS 2017-02 to determine the instrument safety. Proxima Cen is classified as M5.5. However, its effective temperature of 2927 K places the star closer to M6 than M5 (Passegger, Wende-von Berg, Reiners, A&A, 2016). In addition, its radius of ~0.15 Rsun (as in Demory et al., A&A, 2009) is about that of M6. Thus, one should rather use the values for M6 than M5. Given that Proxima Cen is between both limits and that stellar properties do not follow step functions, we consider delta U = -5.4 as a reasonable and physically appropriate value. Attenuating the Lya with the observed interstellar absorption towards Proxima Cen (Wood et al., ApJ, 2001), we find that the brightest pixel has 12.5 cts/s and the global detector count rate is ~3,700 cts/s. Both values are well below the limit. Detailed calculation:

Assuming delta U = -5.4 Flare = U + delta U = 14.21 - 5.4 = 8.81 fU = 1.26e-12, log fU = -11.90log f(C IV) = -10.63, f(C IV) = 2.3e-11log f(S IV) = -10.69, f(Si IV) = 2e-11 $f(Lya) \sim 1e-10$ (from scaling relations) $f(Lya) \sim 8.5e-10$ (from 37 * f(C IV)) These values are 6.2, 7.8, and 7.1 magnitudes below the mean fluxes that already include flares (for C IV, S IV, and Lya, resp.).

BOT: The source reported to possibly violate the bright object limits has the GSC II ID S7Q6372147 at coordinates 14:29:33.02 -62:40:39.12 at a V magnitude of 15.66. The nearest source known to Simbad is our target Proxima Cen although its V magnitude is V=11.13, i.e., significantly brighter in the optical. Galex has observed this field and the nearest (and brightest) source is at 14:29:36.66 -62:40:37.6, which is consistent with the position of our target Proxima Cen during the epoch of the Galex observation (2011.5). The next nearest UV bright source is about two arcmin from our target (14:29:26.313 - 62:40:45.5, Galex objID 6387417244251458407, IAU Name: GALEX J142926.3-624045). Therefore, we consider the field to be safe.

Pr	opo	<u>sal 14860</u>	- FUV (01)	- The most detailed high	n-energy pic	<u>ture of Proxim</u>	a Centau	<u>ri, our nearest e</u>	extrasolar neighbor	
	Pro	Proposal 14860, FUV (01), implementation Thu May 11 01:05:19 GMT 2								GMT 2017
sit	Dia	Diagnostic Status: No Diagnostics								
	Scie	Scientific Instruments: STIS/CCD, STIS/FUV-MAMA								
>	Spe	Special Requirements: GROUP 01,02 WITHIN 5 Orbits								
	Con ente	Comments: To be excecuted simultaneous with (one of) our Chandra LETGS observations (PI Predehl). Details for the Chandra observation are: ObsID 19708, PropNo 18200754. No timing contraints have been entered, because the dates of the Chandra observations are not fixed yet.								
S	#	Name		Target Coordinates	Targ. C	Coord. Corrections		Fluxes	Miscellaneous	
get	(1)	V-V645	5-CEN	RA: 14 29 42.9485 (217.4289521d)	Proper I	Motion RA: -3775.75 n	nas/yr	V=11.13	Reference Frame: ICRS	
ar				Dec: -62 40 46.16 (-62.67949d)	Proper I	Motion Dec: 765.54 ma	ns/yr			
				Equinox: J2000	Epoch of	of Position: 2000				
Fixe	Con larg Exte	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Coordinates are from Hipparcos. Thus, have an accuracy better than about 1 mas for the observing date. Due to large proper motion of Proxima Cen, we adopt a larger uncertainty. Typically, the pm error is about 1 mas/yr from Hipparcos so that the formal uncertainty is still well below 0.1 arcsec for the position. Extended=NO								
	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs	. Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	STIS ACQ	(1) V-V645-CEN	STIS/CCD, ACQ, F28X500III	MIRROR	ACQTYPE=POINT			10 Secs (10 Secs)	
		(STIS.ta.994 017)							[==>]	[1]
s	Con e re	Comments: We chose to use the [O III] filter, because the 28x50LP filter would result in saturation within 0.16 s. Exposure time reflects the time based on the flux around [O III] while most of the flux is likely due to th e red leak. Still saturation occurs only for texp>200 s.								
l a	2	(STIS.sp.92	(1) V-V645-CEN	STIS/FUV-MAMA, TIME-TAG,	E140M	BUFFER-TIME=50			2500 Secs (2579 Secs)	
l S		6199)		0.2X0.2	1425 A	0			[==>2579.0 Secs]	[1]
١ğ	Con	Comments: The buffer time is chosen based on the mean observed spectrum.								
ΠÛ	3	(STIS.sp.92	(1) V-V645-CEN	STIS/FUV-MAMA, TIME-TAG,	E140M	BUFFER-TIME=50			200 Secs (3226 Secs)	
		6199)		0.2X0.2	1425 A	0			[==>3226.0 Secs]	[2]
	4	(STIS.sp.92	(1) V-V645-CEN	STIS/FUV-MAMA, TIME-TAG,	E140M	BUFFER-TIME=50			2500 Secs (3226 Secs)	
		6199)		0.2X0.2	1425 A	0			[==>3226.0 Secs]	[3]
	5	(STIS.sp.92	(1) V-V645-CEN	STIS/FUV-MAMA, TIME-TAG,	E140M	BUFFER-TIME=50			2500 Secs (3226 Secs)	
		6199)		0.2X0.2	1425 A	0			[==>3226.0 Secs]	[4]









Pro	oposal 14860 - NUV/opti	cal (CCD) (02) - The mc	st detailed h	nigh-energy pic	cture of Pro	oxima Centauri	, our nearest extrasolar ne	ighbor
	Proposal 14860, NUV/optical (CCD)) (02)					Thu May 11 01:05:19	GMT 2017
sit	Diagnostic Status: No Diagnostics							
Ϊ	Scientific Instruments: STIS/CCD							
	Special Requirements: GROUP 02,01	WITHIN 5 Orbits						
ŝ	# Name	Target Coordinates	Targ. Coord. Corrections		Fluxes	Miscellaneous		
get	(1) V-V645-CEN	RA: 14 29 42.9485 (217.4289521d)	Proper Motion RA: -3775.75 mas/yr		nas/yr	V=11.13	Reference Frame: ICRS	
ar		Dec: -62 40 46.16 (-62.67949d)	Proper	Motion Dec: 765.54 ma	as/yr			
		Equinox: J2000	Epoch	of Position: 2000				
Fixe	Comments: This object was generated large proper motion of Proxima Cen, w Extended=NO	by the targetselector and retrieved from we adopt a larger uncertainty. Typically	n the SIMBAD datal w, the pm error is ab	base. Coordinates are fr out 1 mas/yr from Hipp	com Hipparcos. T arcos so that the	hus, have an accuracy b formal uncertainty is stil	etter than about 1 mas for the observing dat ll well below 0.1 arcsec for the position.	e. Due to
	# Label Target (ETC Run)	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1 STIS ACQ (1) V-V645-CEN	STIS/CCD, ACQ, F28X50OIII	MIRROR	ACQTYPE=POINT			10 Secs (10 Secs)	
	(STIS.ta.994 017)						[==>]	[1]
	Comments: We chose to use the [O III] e red leak. Still saturation occurs only] filter, because the 28x50LP filter woul for texp>200 s.	ld result in saturatio	on within 0.16 s. Exposu	re time reflects th	he time based on the flux	around [O III] while most of the flux is like	ly due to th
	2 STIS NUV (1) V-V645-CEN	STIS/CCD, ACCUM, 52X0.2	G230LB	CR-SPLIT=8;			2048 Secs (2128 Secs)	
	(STIS.sp.84 0261)		2375 A	SIZEAXIS2=256			[==>266.0 Secs (Split 1)]	
les	0201)						[==>266.0 Secs (Split 2)]	
su							[==>266.0 Secs (Split 3)]	
8							[==>266.0 Secs (Split 4)]	[1]
Ш							[==>266.0 Secs (Split 5)]	[1]
							[==>266.0 Secs (Split 6)]	
							[==>266.0 Secs (Split 7)]	
							[==>266.0 Secs (Split 8)]	
	Comments: The exposure time is about double the value of archival data. We expect S/N > 5 in the continuum for wavelengths longwards of 2500 Angstrom. We use a subarray mode to minimize readout times and a CR-SPLIT=8 to obtain some time resolution.							
	3 STIS blue o (1) V-V645-CEN	STIS/CCD, ACCUM, 52X0.2	G430L	CR-SPLIT=2			33 Secs (33 Secs)	
	ptcal (STIS sp 84		4300 A				[==>(Split 1)]	(1)
	0259)						[==>(Split 2)]	[1]

Proposal 14860 - NUV/optical (CCD) (02) - The most detailed high-energy picture of Proxima Centauri, our nearest extrasolar neighbor

