



14347 - Joint VLA and HST Observations of Brown Dwarf Aurorae

Cycle: 23, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
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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) LSR (4) LSR-OFFSET	COS/FUV COS/NUV	3	01-Apr-2016 21:03:30.0	yes
02	(2) TVLM (3) TVLM-OFFSET	COS/FUV COS/NUV	2	01-Apr-2016 21:03:31.0	yes

5 Total Orbits Used

ABSTRACT

Over the past decade a small number of very-low mass stars and brown dwarfs have been unexpectedly detected as radio sources (Antonova et al. 2012). Moreover, follow-up observations have revealed coherent, 100% circularly polarized radio pulsed modulated at the 2-3 hour rotational periods of these objects (Hallinan et al. 2007,2008). These observations are consistent with being produced by the electron cyclotron maser instability that produces radio aurorae from magnetized giant planets. Additionally, all of these objects exhibit H-alpha emission which has recently been shown in one example object to be physically associated with the radio aurorae (Hallinan et al. 2015). This evidence points toward a coherent picture of brown

dwarf activity as the consequence of large-scale magnetospheric current systems accelerating a population of electrons that precipitate into the brown dwarf upper atmospheres. This same mechanism powers the multi-wavelength aurorae of the magnetized planets in the Solar System. Consequently, we expect the observed brown dwarf radio aurorae to be accompanied by strong aurorae in the FUV. We perform simultaneous observations using the NRAO Very Large Array and the Hubble Space Telescope Cosmic Origins Spectrograph to look for and characterize the ultraviolet aurorae of two brown dwarfs. These observations provide constraints on the properties of the energetic electron beam, the electrodynamic engine and the efficiency of the electron cyclotron maser mechanism. Additionally, these observations allow us to study the upper atmospheres of brown dwarfs and begin exploring auroral physics beyond the Solar System.

OBSERVING DESCRIPTION

Brown dwarfs have been recently shown to exhibit strong auroral phenomena at radio and optical wavelengths (Hallinan et al. 2015). These emissions are powered by an accelerated electron beam precipitating into the upper atmosphere, a consequence of large scale magnetospheric current systems. Like the aurorae of the Solar System giant planets, the interaction of the high-energy beam with the molecular hydrogen dominated atmosphere leads to the production of hydrogen Balmer series emission as well as strong emissions at ultraviolet wavelengths. The UV emissions are a consequence of the electron impacts exciting the Lyman and Werner band electronic states of H₂ which subsequently emit thousands of narrow molecular emission features between 1200-1650 angstroms. To understand the auroral process in brown dwarfs we are conducting simultaneous observations using the VLA and HST-COS of two auroral brown dwarfs, TVLM513 and LSR1835.

Based on the relative energy scaling of the UV and optical emission features of the Jovian aurorae (the best estimate for brown dwarf aurorae), we constructed an electron-impact like H₂ UV spectrum with an average flux density of $1e-14$ ergs/s/cm²/Å between 140.0 nm and 170.0 nm. Using the STScI COS exposure time calculator we determined that the FUV auroral spectrum is readily detectable during the time of a single HST orbit. The emission, however, is rotationally modulated and requires monitoring to insure that we observe it.

Our coordinated observations will monitor TVLM513 for 5 hours in the radio and through 2 contiguous orbits with HST as well as LSR1835 for 6.5 hours in the radio and 3 contiguous orbits with HST. These monitoring observations will cover more than a full rotational period of each object (1.97 hrs and 2.84 hrs respectively for TVLM513 and LSR1835) to ensure that we observe the rotationally varying emission despite the observing windows only covering a portion of each orbit.

The HST-COS observations will use the G160M grating at the two central wavelength positions 157.7 and 162.3 nm in the TIME-TAG mode

Proposal 14347 (STScI Edit Number: 1, Created: Friday, April 1, 2016 8:03:32 PM EST) - Overview

through the PSA aperture. The two wavelength settings will allow us to get the full spectrum from 140.0 nm to 180. nm where we expect to see the FUV auroral emission. Operating in TIME-TAG mode will also allow us to discern the time variability of the emission during the long exposures of each orbit. The G160M grating is very sensitive and has a high resolution which is key for observing the faint aurorae and discerning the contribution from the many molecular emission lines. It will also allow us to determine the excitation mechanism of the H₂ emission.

The UV observations will determine the energetics of the auroral process in brown dwarfs atmospheres and in conjunction with the radio observations allow us to constrain the efficiency of the radio auroral process and the amount of energy in the electron beam.

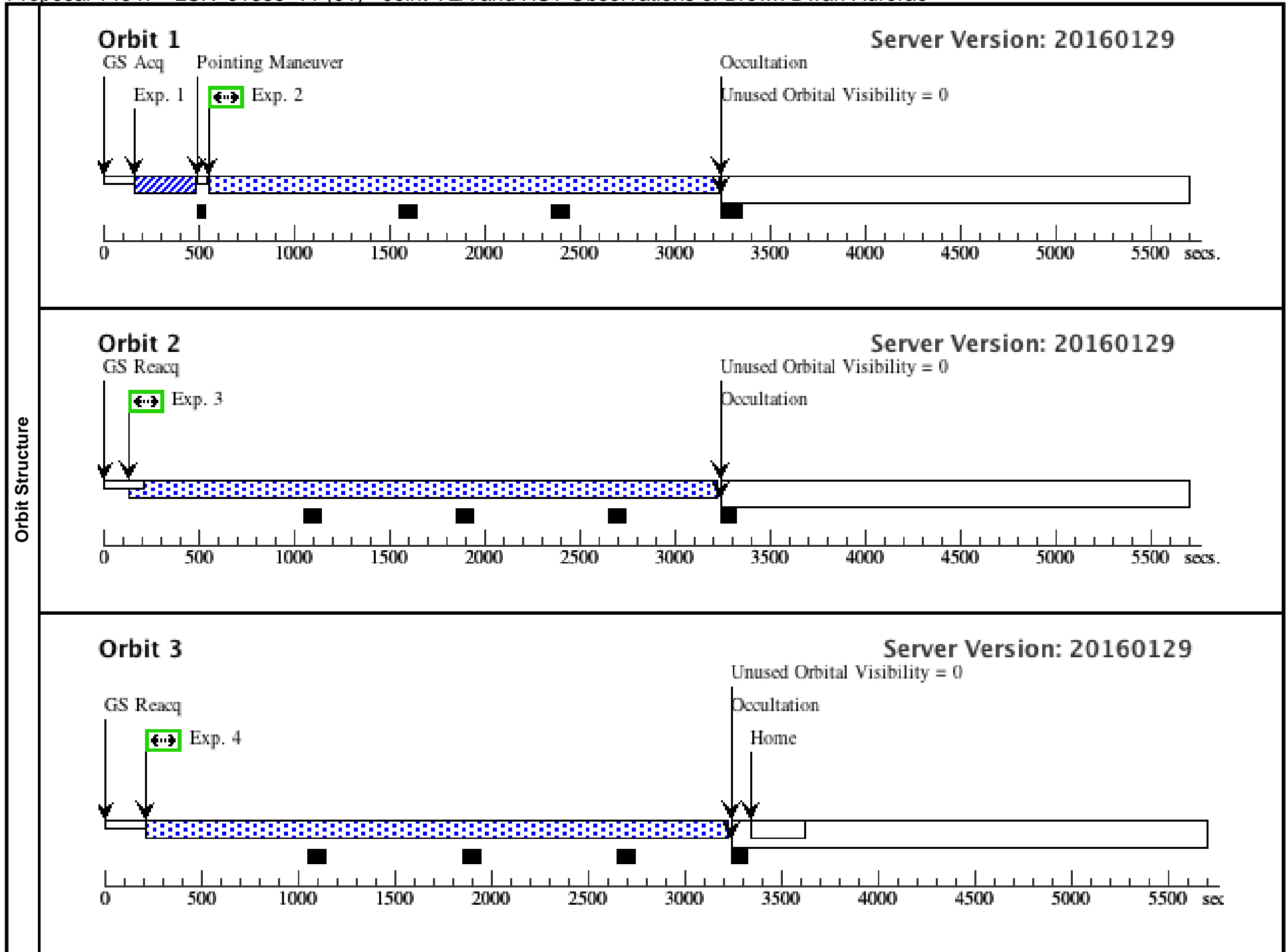
Proposal 14347 - LSR_J1835_v1 (01) - Joint VLA and HST Observations of Brown Dwarf Aurorae

Sat Apr 02 01:03:33 GMT 2016

Visit	<p>Proposal 14347, LSR_J1835_v1 (01), implementation</p> <p>Diagnostic Status: Warning</p> <p>Scientific Instruments: COS/FUV, COS/NUV</p> <p>Special Requirements: (none)</p> <p><i>Comments: The observing plan will be to split COS G160M observations into two CENWAVE settings (1577 and 1623) at multiple FP-POS positions (1, 2, and 4). This will distribute the photon arrival rate(which will be low for this target) while providing continuous spectral coverage (which is important for distinguishing between H2 excitation mechanisms, one of the prime science drivers for this program). The visit will use 3 orbits to observe through the full rotational period of the target and capture rotational modulation of the signal.</i></p> <p><i>Target fields have been cleared for bright object concerns. 03/21/16.</i></p> <p><i>The target acquisition object has a bright object concern from the GSC catalogue on the offset acquisition target (TVLM-OFFSET), however the same object is cleared by a known GALEX NUV flux. The GSC BOT flag is based on an assumption of a hot O star. The B-V color place the star as an Early G. Even assuming the bright earlier F star, the 100 sec exposure poses no threat to the NUV detector.</i></p>																																			
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Proposal 14347 - LSR J1835 v1 (01) - Joint VLA and HST Observations of Brown Dwarf Aurorae

Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
	1	LSR_J1835 _ACQ (COS.ta.783 785)	(4) LSR-OFFSET	COS/NUV, ACQ/IMAGE, PSA	MIRRORA					47 Secs (47 Secs) [==>]	[1]
	<i>Comments: etc run and T_exp estimated from COS.ta.783785</i>										
	2	LSR_J1835 _SPEC1 (COS.sp.783 789)	(1) LSR	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FP-POS=2; BUFFER-TIME=80 0				2461 Secs (2461 Secs) [==>]	[1]
	<i>Comments: etc run and T_exp estimated from COS.sp.783789</i>										
3	LSR_J1835 _SPEC2 (COS.sp.737 181)	(1) LSR	COS/FUV, TIME-TAG, PSA	G160M 1623 A	FP-POS=1; BUFFER-TIME=80 0				2971 Secs (2959 Secs) [==>2959.0 Secs]	[2]	
<i>Comments: etc run and T_exp estimated from COS.sp.737181</i>											
4	LSR_J1835 _SPEC3 (COS.sp.737 181)	(1) LSR	COS/FUV, TIME-TAG, PSA	G160M 1623 A	FP-POS=4; BUFFER-TIME=80 0				2971 Secs (2959 Secs) [==>2959.0 Secs]	[3]	
<i>Comments: etc run and T_exp estimated from COS.sp.737181</i>											



Proposal 14347 - TVLM 513 v2 (02) - Joint VLA and HST Observations of Brown Dwarf Aurorae

Sat Apr 02 01:03:33 GMT 2016

Visit	<p>Proposal 14347, TVLM_513_v2 (02), implementation</p> <p>Diagnostic Status: Warning</p> <p>Scientific Instruments: COS/FUV, COS/NUV</p> <p>Special Requirements: (none)</p> <p><i>Comments: The observing plan will be to split COS G160M observations into two CENWAVE settings (1577 and 1623) at multiple FP-POS positions (1, 2, and 4). This will distribute the photon arrival rate(which will be low for this target) while providing continuous spectral coverage (which is important for distinguishing between H2 excitation mechanisms, one of the prime science drivers for this program). The visit will use 2 orbits to observe through the full rotational period of the target and capture rotational modulation of the signal.</i></p> <p><i>Target fields have been cleared for bright object concerns. 08/12/15.</i></p> <p><i>The target acquisition object has a bright object concern from the GSC catalogue on the offset acquisition target (TVLM-OFFSET), however the same object is cleared by a known GALEX NUV flux. The GSC BOT flag is based on an assumption of a hot O star. The sloan photometry and the B-V color place the star as late F/ Early G. Even assuming the bright earlier F star, the 100 sec exposure poses no threat to the NUV detector.</i></p>																																			
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Proposal 14347 - TVLM 513 v2 (02) - Joint VLA and HST Observations of Brown Dwarf Aurorae

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	1	TVLM_513 _ACQ2 (COS.ta.737 169)	(3) TVLM-OFFSET	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			GS ACQ SCENARI O BASE1B3		100 Secs (100 Secs) [==>]	[1]
	<i>Comments: etc run and T_exp estimated from COS.ta.737169</i>										
	2	TVLM_513 _SPEC1 (COS.sp.737 174)	(2) TVLM	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FP-POS=2; BUFFER-TIME=80 0				900 Secs (1065 Secs) [==>1065.0 Secs]	[1]
	<i>Comments: etc run and T_exp estimated from COS.sp.737174</i>										
3	TVLM_513 _SPEC2 (COS.sp.737 175)	(2) TVLM	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FP-POS=4; BUFFER-TIME=80 0				972 Secs (1137 Secs) [==>1137.0 Secs]	[1]	
<i>Comments: etc run and T_exp estimated from COS.sp.737175</i>											
4	TVLM_513 _SPEC3 (COS.sp.737 176)	(2) TVLM	COS/FUV, TIME-TAG, PSA	G160M 1623 A	FP-POS=1; BUFFER-TIME=80 0				2946 Secs (2936 Secs) [==>2936.0 Secs]	[2]	
<i>Comments: etc run and T_exp estimated from COS.sp.737176</i>											

