



# 14617 - Auroral properties of the brown dwarf LSR J1835 + 3259: The UV perspective

Cycle: 24, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

## INVESTIGATORS

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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-J1835+3259	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	5	07-Sep-2016 17:40:49.0	yes

5 Total Orbits Used

## ABSTRACT

Auroral activity has been observed for the first time on an object outside of the solar system, i.e., on the brown dwarf LSR J1835 + 3259 (Hallinan et al. 2015). The auroral emission has been identified only through observations at radio wavelengths and the Balmer lines combined with detailed modeling of their light curves. We propose to observe this brown dwarf within five orbits to characterize its UV emission over a broad spectral range. (a) Our observations will be an entirely different approach to model-independently establish the auroral emission of the brown dwarf. (b) These observations will essentially test whether the aurora on LSR 1835 + 3259 is a gigantically-upscaled version from Jupiter. (c) Observations over a significant range in UV wavelength provide crucial information about the nature of the auroral accelerator mechanisms and magnetospheric properties of the brown dwarf particularly when combined with observations at other wavelengths. These observations together with theory of spectral and temporal auroral emissions thus provide a new means to explore the plasma properties and the physical processes in the magnetosphere of the brown dwarf. It will allow models of aurora generation extensively tested by in-situ spacecraft observations in our solar system to probe extra-solar objects.

## **OBSERVING DESCRIPTION**

We will use STIS with three different gratings to explore the UV emission of LSR J1835+3259 over a broad spectral range. We propose five consecutive orbits with one orbit in the NUV, three orbits in the FUV without Ly-alpha, and one orbit for the Ly-alpha wings. We specifically ask for the orbits in the following order: 1. FUV, 2. NUV, 3. Ly-alpha wings, 4. FUV, 5. FUV. The reason will be given below.

### **NUV-Range**

We will use STIS and first order grating G230L (1570-3180 Å) to investigate and confirm the emission from LSR J1835+3259 in the NUV range. The grating has a dispersion of 1.58 Å/pixel and an average throughput of approximately 0.01. Previous observations in nearly the same wavelength range measured an averaged flux of  $4.7 \times 10^{-21} \text{ W m}^2 / \text{Å}$  (Berger et al. 2008). STIS will be able to re-identify this flux integrated over the whole wavelength range with  $s/n = 25$  during an exposure time of 30 min.

### **FUV-Range without Ly-ALPHA**

We will use STIS and first order grating G140L (1150-1730 Å) in order to investigate the auroral FUV emission, its spectral structure and time-variability. The grating has a dispersion of 0.6 Å/pixel and an average throughput of approximately 0.015. Because geocoronal light is not an issue at the wavelengths of interest, we will use the 52 arcsec x 0.2 arcsec slit. The total auroral fluxes within this FUV range are predicted to be 10 times larger compared to the NUV-Range. Therefore we will achieve  $s/n = 10$  within an exposure time of 1 min if we integrate over all fluxes leaving out Ly-ALPHA. Thus auroral fluxes in this wavelength range should be easily observable.

### Ly-ALPHA wings

We will use STIS and first order grating G140M (1190-1245 Å) at central wavelength = 1218 Å to observe the Ly-ALPHA wings. STIS with this grating provides a good compromise between spectral resolution and sensitivity. The dispersion of the grating is 0.04 Å/pixel. The throughput at Ly-ALPHA wavelengths  $\lambda_{\text{Ly-ALPHA}} = 1215.67 \text{ Å}$  is  $\sim 0.015$ . We use the 52 arcsec x 0.05 arcsec slit to minimize the geocoronal background. We expect fluxes above the background in the range of  $3 \times 10^{-18}$  to  $3 \times 10^{-16} \text{ W m}^{-2} / \text{Å}$ . With an exposure time of 35 minutes these fluxes will be observable with an associated s/n range of 3 to 32 and thus should be well detectable within one HST orbit.

The wavelength range 1215.4 to 1215.8 Å around the center of Ly-ALPHA line is subject to strong absorption of the original signal due to interstellar hydrogen. The same wavelength range is additionally strongly contaminated by geocoronal emission. Therefore we will only study the emission outside this wavelength range.

All observations will be carried out in time-tag mode to remove time intervals with large geo-coronal noise at the beginning and end of an orbit.

### Coverage of FUV variability:

The main goal of the proposal is to measure the auroral intensity of LSR J1835+3259 at various UV wavelengths. The optical and radio emission of the brown dwarf is however also subject to periodic variability with a period of 2.84 hours. In the Balmer lines the variability is up to 40% and in the UV the variability is unknown, but might be significantly stronger. To separate variability as a function of wavelength from temporal variability we need to investigate the possible variability of the FUV light curve. This is well possible with our G140L observation in the FUV range without the Ly-ALPHA. Integrated fluxes over the whole wavelength range lead to s/n  $\sim 10$  within 60 seconds. All observation will be taken in time-tag mode to accordingly rebin the observations into the desired subinterval.

To extract the FUV variability we apply the following strategy:

The light curve of LSR J1836+3259 has a period of 2.84 h = 170.4 min. It will be sampled by observations of ca. 35 min duration on consecutive HST orbits spaced by 96 min. We plan to use the following strategy in order to optimize the detection of the light curve variability:

Let  $\phi_1$  be the phase of the light curve on the first orbit of the visit.  $\phi$  runs from 0 to 1. Then the phases for the following orbits are:  $\phi_2 = \phi_1 + 0.569$ ,  $\phi_3 = \phi_1 + 0.138$ ,  $\phi_4 = \phi_1 + 0.708$ ,  $\phi_5 = \phi_1 + 0.277$ . Determining the light curve on consecutive orbits, say, 1, 2, and 3 is not optimal. Orbit 2 will be roughly shifted by half a period and orbit 3 will cover roughly the same phase as orbit 1, yielding no new information. Instead, we plan to determine the light curve on orbit 1, 4, and 5. The phases will be  $\phi_1$ ,  $\phi_1 + 0.708$ , and  $\phi_1 + 0.277$ . This way it will be ensured that the observations are spread out over the different phases of the light curve as well as possible. Each observation of ca. 35 min duration

Proposal 14617 (STScI Edit Number: 0, Created: Wednesday, September 7, 2016 4:40:50 PM EST) - Overview

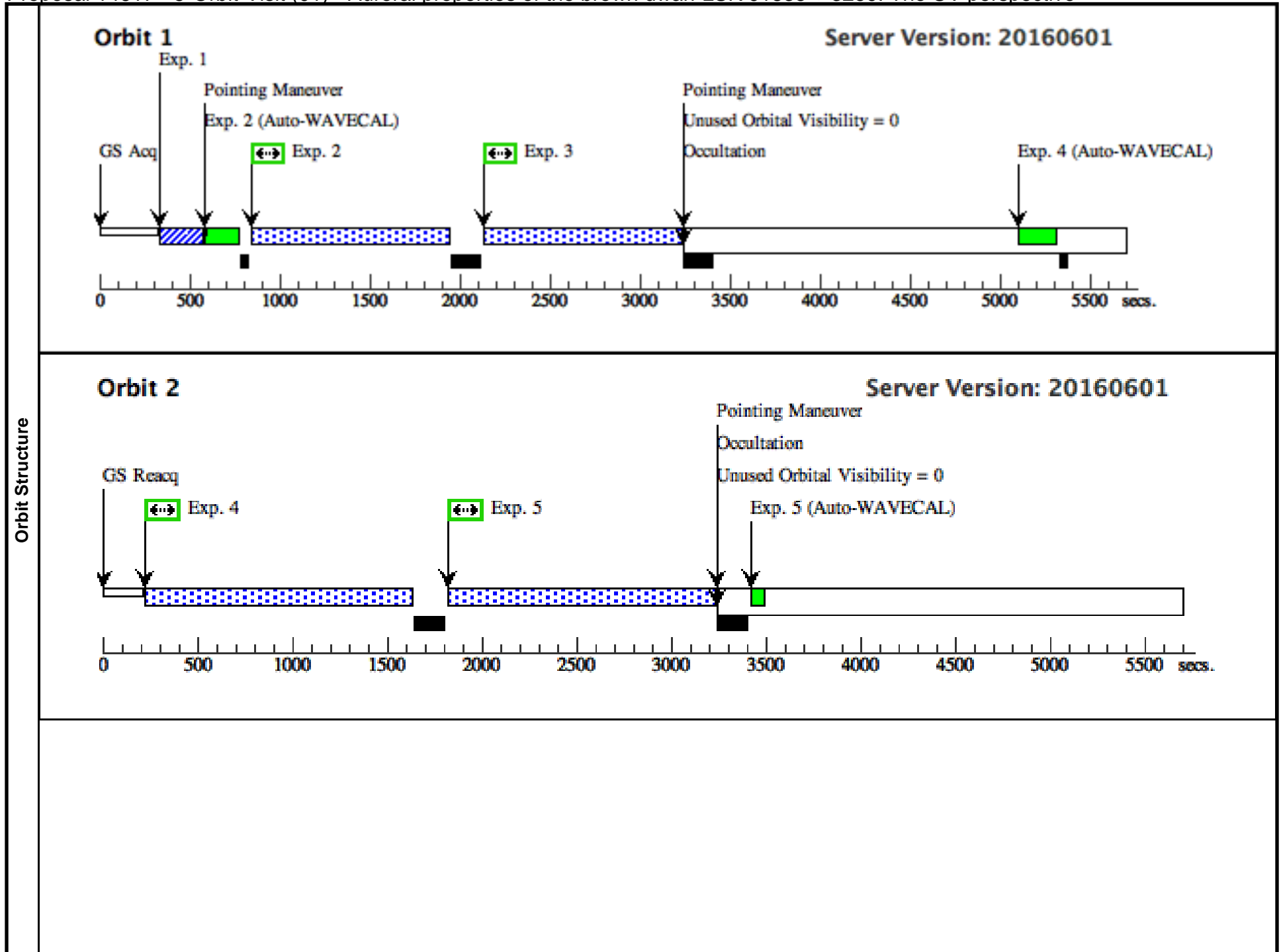
corresponds to a phase coverage of  $\pm 0.1$ . Thus the total coverage of the light curve in terms of phase relative to  $\phi_1$  will be:  $[-0.1, 0.1]$ ,  $[0.608, 0.808]$ ,  $[0.177, 0.377]$ .

Proposal 14617 - 5-Orbit-Visit (01) - Auroral properties of the brown dwarf LSR J1835 + 3259: The UV perspective

<b>Visit</b>	<b>Proposal 14617, 5-Orbit-Visit (01), implementation</b> <span style="float: right;">Wed Sep 07 21:40:50 GMT 2016</span> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, STIS/FUV-MAMA Special Requirements: (none)					
	<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>
(1)		LSR-J1835+3259	RA: 18 35 37.9020 (278.9079250d) Dec: +32 59 54.59 (32.99850d) Equinox: J2000	Proper Motion RA: -40 mas/yr Proper Motion Dec: -759 mas/yr Parallax: 0.1765" Epoch of Position: 2000 Radial Velocity: 8.4 km/sec	V=18.27+/-0.03 Spectral type: M8.5V	Reference Frame: ICRS
<i>Comments: Extended=NO</i>						

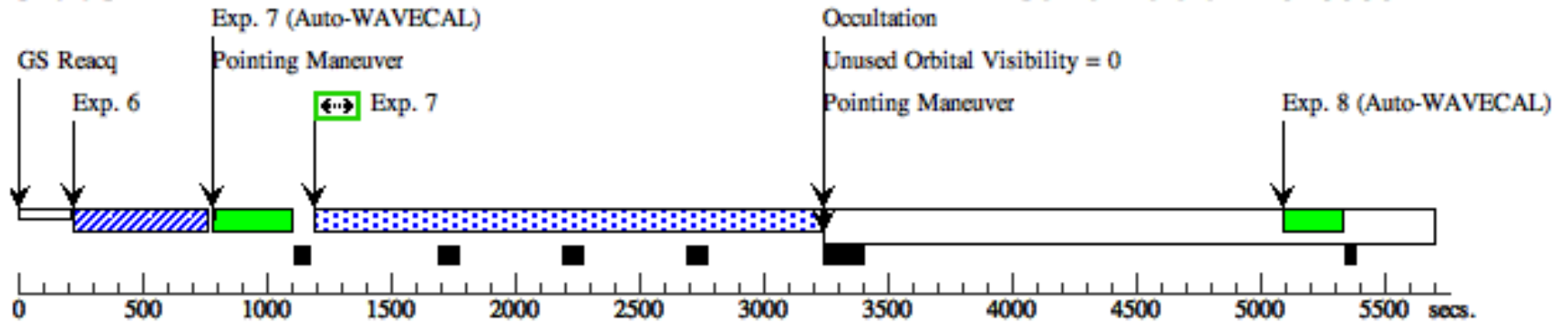
Proposal 14617 - 5-Orbit-Visit (01) - Auroral properties of the brown dwarf LSR J1835 + 3259: The UV perspective

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
Exposures	1	Acquisition	(1) LSR-J1835+3259 STIS/CCD, ACQ, F28X50LP	MIRROR			Sequence 1-3 Non-Int in 5-Orbit-Visit (01)	3 Secs (3 Secs) [==>]	[1]
	2	FUV1-SCIENCE (STIS.sp.82 2467)	(1) LSR-J1835+3259 STIS/FUV-MAMA, TIME-TAG, 52X0.2D1	G140L 1425 A	BUFFER-TIME=60 0		Sequence 1-3 Non-Int in 5-Orbit-Visit (01)	1083 Secs (1083 Secs) [==>]	[1]
	3	FUV1-SCIENCE (STIS.sp.82 2467)	(1) LSR-J1835+3259 STIS/FUV-MAMA, TIME-TAG, 52X0.2D1	G140L 1425 A	BUFFER-TIME=60 0		Sequence 1-3 Non-Int in 5-Orbit-Visit (01)	1084 Secs (1084 Secs) [==>]	[1]
	4	NUV-Science (STIS.sp.82 2467)	(1) LSR-J1835+3259 STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=70 0.0		Sequence 4-5 Non-Int in 5-Orbit-Visit (01)	1395 Secs (1395 Secs) [==>]	[2]
	5	NUV-Science (STIS.sp.82 2467)	(1) LSR-J1835+3259 STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=70 0.0		Sequence 4-5 Non-Int in 5-Orbit-Visit (01)	1394 Secs (1394 Secs) [==>]	[2]
	6	Lymalpha-Acquisition (STIS.ta.825 079)	(1) LSR-J1835+3259 STIS/CCD, ACQ/PEAK, 52X0.05D1	MIRROR			Sequence 6-7 Non-Int in 5-Orbit-Visit (01)	10 Secs (10 Secs) [==>]	[3]
	7	LYM-ALPHA-WINGS-SCIENCE (STIS.sp.82 3043)	(1) LSR-J1835+3259 STIS/FUV-MAMA, TIME-TAG, 52X0.05D1	G140M 1218 A	BUFFER-TIME=50 0.		Sequence 6-7 Non-Int in 5-Orbit-Visit (01)	2020 Secs (2020 Secs) [==>]	[3]
	8	FUV2-SCIENCE (STIS.sp.82 2467)	(1) LSR-J1835+3259 STIS/FUV-MAMA, TIME-TAG, 52X0.2D1	G140L 1425 A	BUFFER-TIME=70 0.00		Sequence 8-9 Non-Int in 5-Orbit-Visit (01)	1395 Secs (1395 Secs) [==>]	[4]
	9	FUV2-SCIENCE (STIS.sp.82 2467)	(1) LSR-J1835+3259 STIS/FUV-MAMA, TIME-TAG, 52X0.2D1	G140L 1425 A	BUFFER-TIME=70 0.0		Sequence 8-9 Non-Int in 5-Orbit-Visit (01)	1394 Secs (1394 Secs) [==>]	[4]
	10	FUV3-SCIENCE (STIS.sp.82 2467)	(1) LSR-J1835+3259 STIS/FUV-MAMA, TIME-TAG, 52X0.2D1	G140L 1425 A	BUFFER-TIME=70 0.00		Sequence 10-11 Non-Int in 5-Orbit-Visit (01)	1395 Secs (1395 Secs) [==>]	[5]
	11	FUV3-SCIENCE (STIS.sp.82 2467)	(1) LSR-J1835+3259 STIS/FUV-MAMA, TIME-TAG, 52X0.2D1	G140L 1425 A	BUFFER-TIME=70 0.00		Sequence 10-11 Non-Int in 5-Orbit-Visit (01)	1394 Secs (1394 Secs) [==>]	[5]



**Orbit 3**

Server Version: 20160601



**Orbit 4**

Server Version: 20160601

