13310 - The life and death of H2 in a UV-rich environment - Towards a better understanding of H2 excitation and destruction

Cycle: 21, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Nicholas P. Abel (PI) (Contact)	**University of Cincinnati Main Campus**	**npabel2@gmail.com**
Dr. Gary J. Ferland (CoI)	University of Kentucky	gary@pa.uky.edu
Dr. C. Robert O'Dell (CoI)	Vanderbilt University	cr.odell@vanderbilt.edu
Dr. Thomas H. Troland (CoI)	University of Kentucky	troland@pa.uky.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) V-BM-ORI	STIS/CCD STIS/FUV-MAMA	4	24-Jun-2013 22:16:02.0	yes

4 Total Orbits Used

ABSTRACT

Molecular hydrogen (H2) is the most abundant molecule in the universe. H2 is also a catalyst for the formation of other molecules like CO that are used to infer physical conditions in molecular gas. Therefore, it is crucial to understand H2 formation and destruction processes. Most existing H2 UV absorption studies sample regimes where H2 has already formed, and the level populations are thermalized. However, the Orion Veil, a thin layer immediately (~ 1 pc) in front of the Trapezium stars, offers a different environment. There, the fractional abundance of H2 is low, and UV radiation pumps H2 to high vibration and rotation levels. In this environment, comparisons between theory and observation provide stringent tests of

models of H2 formation and destruction.

For the Veil, we seek to compare STIS observations of vibrationally and rotationally excited H2 absorption lines with predictions of chemical models in the Cloudy code. Model calculations predict we will detect dozens of H2 lines from high vibration and rotational levels in the wavelength range 1133-1335A. We hope to address three important questions: (1) Why do chemical models fail to reproduce the observed spectrum of H2 in high rotation and vibration levels? (2) Why are observed PDR temperatures inconsistent with known processes of heating and cooling? (3) Is the deduced H2 destruction rate consistent with recent theories of formation on grain surfaces? Answers to these questions will significantly improve chemical models in Cloudy. Since Cloudy is publicly available, improvements in its chemical models will benefit other investigators studying the physics of molecular gas and PDRs.

OBSERVING DESCRIPTION

Our goal is to achieve high resolution, high SN UV spectra of the line of sight towards the Trapezium in the hope of understanding the formation and destruction of H2 in environments exposed to a strong UV flux, such as at the interface of HII regions and molecular clouds. To this end we will use the E140H spectral element. Over four orbits spanning about 8000 seconds, we will obtain a spectrum covering the wavelength range 1133 - 1335 Angstroms, with a central wavelength of 1234 Angstroms. This wavelength regime does overlap with the 1170-1372 observations covered in program 8273. However, as outlined in Phase I, a significant number of H2 lines are predicted to be in the 1133 - 1170 range. Additionally, archival proposal 10636 combined with theoretical calculations using the spectral synthesis code Cloudy show that, in order to observe the H2 lines, a superior S/N is needed than offered by the single 1271 second spectra observed in GO 8273 . These previous experiences point to both the choice of wavelength coverage, and the overall observing time. The aperture we have chosen, 0.2"x0.09", will give us high resolution while decreasing the length of the exposure. Since the aperture is less than 0.1", a peak-up is required. We used the exposure time calculator to determine the length of time required for target acquisition and peak-up. These turned out to be identical to previous programs for this line of sight. We also need to use a neutral density filter during peakup to protect the CCD from the bright object limit from other nearby Trapezium stars. Our exposure time calculations, shown in the "spectroscopy" tabs under the "visits" section of Phase II, shows that an 8000 second observation will allow us to achieve an S/N of 40 - 60 over the wavelength range 1130 - 1170 angstroms. Such an S/N is larger than the S/N achieved when H2 was originally detected in the GO 8273. We will also achieve an S/N well over 100 for the rest of the wavelength range covered by this proposal, allowing us to several more H2 column densities in various rotational/vibrational levels than possible with previous observations of this sightline. The count rate also falls well below the bright object limit for our proposed target for all settings. Because HD 37021 is a binary system, we have specified times to avoid making our proposed observation, in order to guarantee that the observation is carried out when the system is at maximum brightness. To this end, the period,

HJD, and phase have all been specified in the visit and initial exposure. The proposed range of wavelengths will allow us to observe low H2 column density absorption lines along with providing enough resolution to detect, in multiple velocity components, many other species. Profile fitting of the observed lines will allow us to further refine the physical state of the Veil, including its distance from the Trapezium, chemical abundances, thickness, and its balance between thermal, magnetic, and gravitational energies.

Visit

Proposal 13310, First Orbit (01) Tue Jun 25 02:16:12 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: Period 6.4705315 D AND ZERO-PHASE HJD2455548.738

Fixed Targets

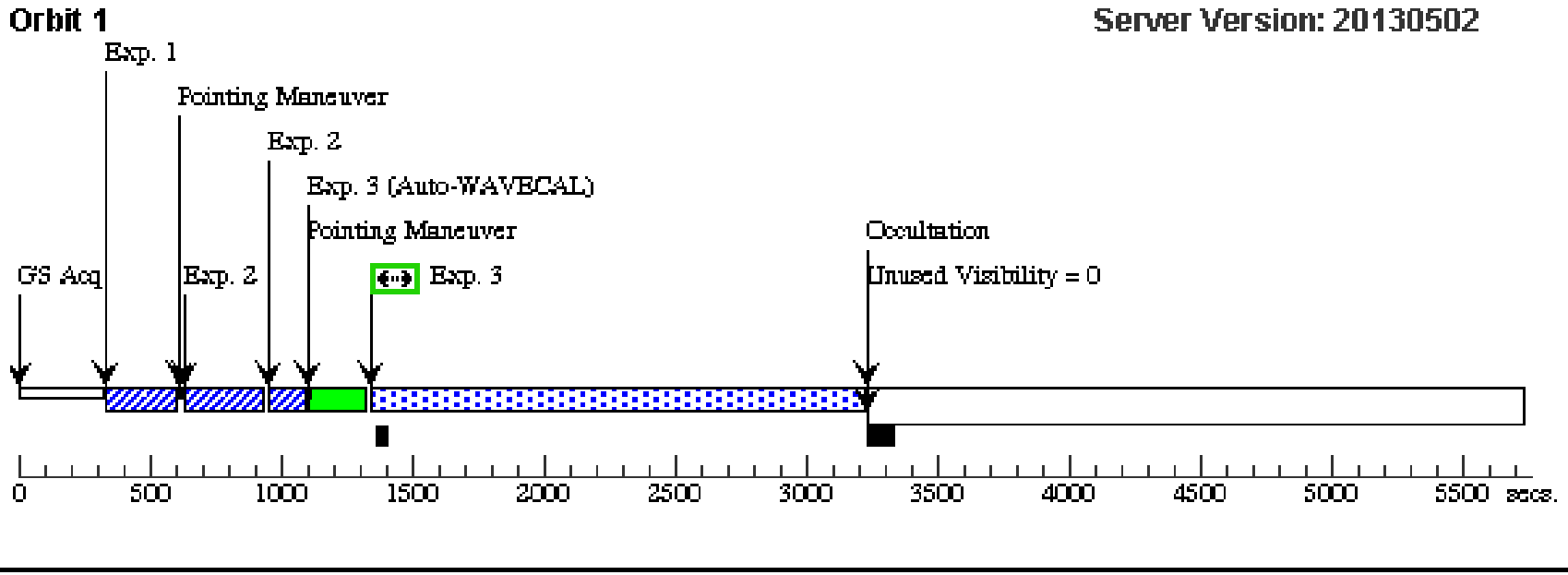
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-BM-ORI Alt Name1: HD37021	RA: 05 35 16.1170 (83.8171542d) Dec: -05 23 6.86 (-5.38524d) Equinox: J2000	Proper Motion RA: -0.000062000 sec of time/yr Proper Motion Dec: 0.000130000 arcsec/yr Parallax: 0.0" Epoch of Position: 1991.25	V=7.96 3x10^-11 erg/s/cm^2 at 1270 Angstroms	Reference Frame: ICRS

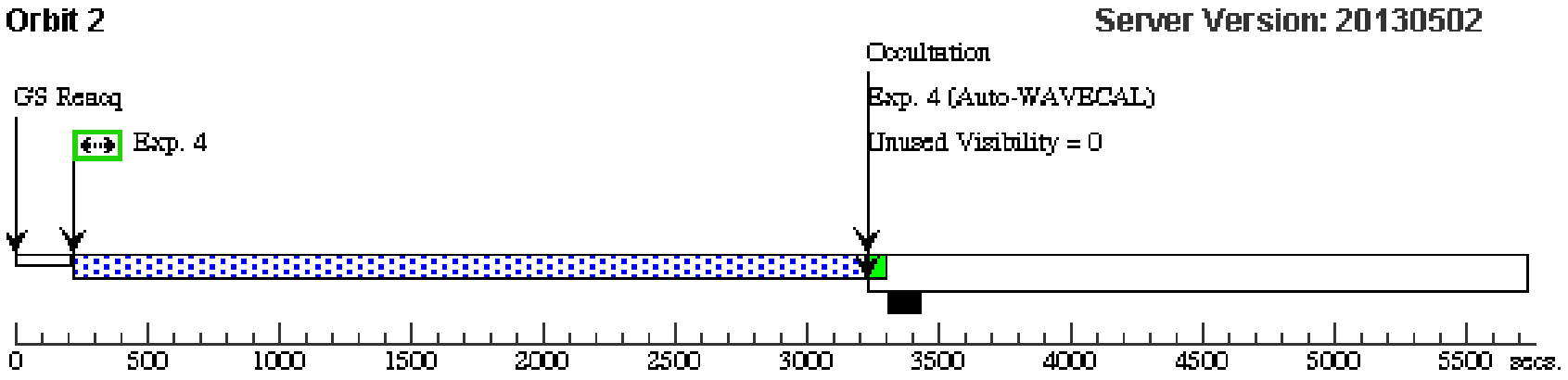
Comments: Our coordinates are taken from two previous programs that observed our proposed target over different wavelength ranges. These programl ID numbers are 8273 and 9465. They take the coordinates from the HIPPARCHOS catalogue. We also checked this against coordinates taken from the van Altena source, corrected according to earlier HST WFPC2 images. This yielded identical results. We list the following reference in regards to this use of source: (van Altena et al. 1988, AJ, 95, 1744). The quoted flux at 1270 is taken from data obtained from proposal ID# 8273

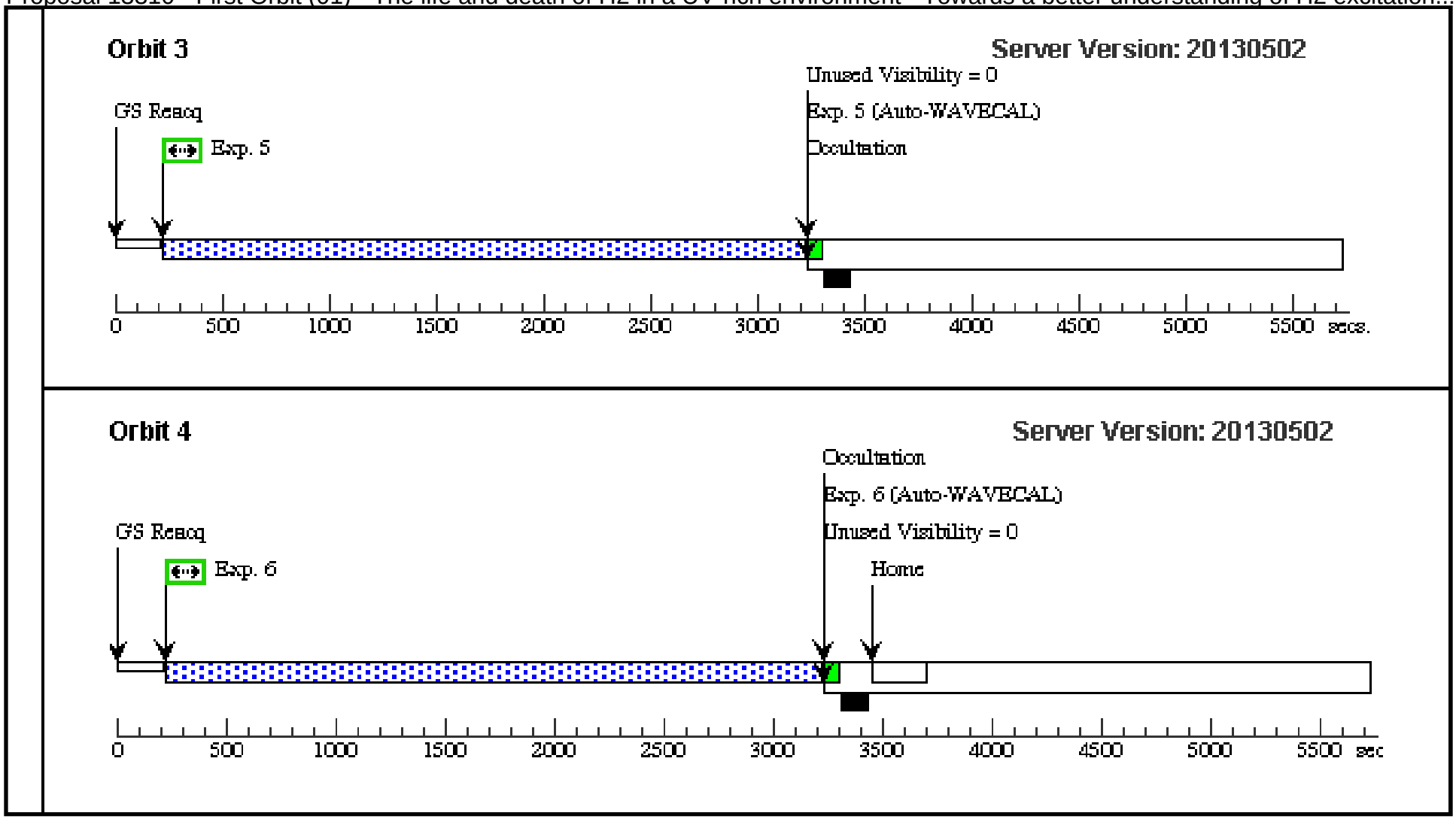
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acquire Ori B	(1) V-BM-ORI	STIS/CCD, ACQ, F28X50OIII	MIRROR		PHASE 0.06 TO 0.92		0.1 Secs (0.1 Secs) *[==>]*	***[1]***
2	Peak-Up	(1) V-BM-ORI	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.4 Secs (0.4 Secs) *[==>]*	***[1]***
3	Spectroscopy - Orbit 1 (STIS.sp.506968)	(1) V-BM-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1234 A				2000 Secs (1860 Secs) *[==>1860.0 Secs]*	***[1]***
4	Spectroscopy - Orbit 2 (STIS.sp.506968)	(1) V-BM-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1234 A				2000 Secs (2981 Secs) *[==>2981.0 Secs]*	***[2]***
5	Spectroscopy - Orbit 3 (STIS.sp.506968)	(1) V-BM-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1234 A				2000 Secs (2981 Secs) *[==>2981.0 Secs]*	***[3]***
6	Spectroscopy - Orbit 4 (STIS.sp.506968)	(1) V-BM-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1234 A				2000 Secs (2981 Secs) *[==>2981.0 Secs]*	***[4]***

Orbit Structure






Orbit 3
Server Version: 20130502
Unused Visibility = 0
GS Reacq
Exp. 5 (Auto-WAVECAL)
Exp. 5
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.
Orbit 4
Server Version: 20130502
Occultation
Exp. 6 (Auto-WAVECAL)
GS Reacq
Unused Visibility = 0
Exp. 6
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec