



## 12901 - An Inventory of Gas in a Debris Disk: Far-UV Spectroscopy of 49 Ceti

Cycle: 20, Proposal Category: GO

(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) 49-CET	STIS/CCD STIS/FUV-MAMA	2	27-Jun-2012 21:07:37.0	yes
02	(1) 49-CET	STIS/CCD STIS/FUV-MAMA	2	27-Jun-2012 21:07:49.0	yes

4 Total Orbits Used

### ABSTRACT

Debris disks stand between gas-rich protoplanetary disks and mature planetary systems, shedding light on the late stages of planetary system formation. Their dust component has been extensively studied, yet has provided little information about disk chemical composition. More information can be provided by their gas content, but astonishingly little is known about it. Only one debris disk has a fairly complete inventory of its gas, which is surprisingly carbon-rich (Beta Pictoris; Roberge et al. 2006). Basic questions remain unanswered. What are the typical gas-to-dust mass ratios in debris disks? What is the chemical composition of debris gas and its parent material? The answers to these questions have profound

implications for terrestrial planet assembly and the origins of planetary atmospheres.

Most detections of debris gas were achieved with line-of-sight UV/optical absorption spectroscopy of edge-on disks, using the central star as the background source. This technique is far more sensitive to small amounts of gas than current emission line studies. The far-UV bandpass is particularly important, since strong transitions of abundant atomic, ionic, and molecular species lie there. We propose extending our intriguing studies of the Beta Pic gas with STIS far-UV spectroscopy of a highly promising debris disk system, 49 Ceti. This well-known disk is edge-on and contains CO gas (e.g. Hughes et al. 2008). We plan to measure column densities of the most important gas species (C I, C II, O I, CO, Si II, and Fe II), find the relative elemental gas abundances, and determine the total gas mass using a powerful gas disk modeling code (ProDiMo; Woitke, Kamp, & Thi 2009).

## **OBSERVING DESCRIPTION**

**General Strategy:** A high-resolution STIS FUV spectroscopic study of the 49 Ceti debris disk system. This disk is ideally suited for a sensitive probe of its gas content, as it is nearly edge-on and known to contain CS gas. Furthermore, the central star is a nearby A1V star, making it bright enough in the FUV to obtain high S/N spectra that can be used to detect superimposed gas absorption lines. We are targeting strong FUV absorption lines of O I (at 1302 Å), C I (at 1657 Å and 1560 Å), and C II (at 1335 Å). These are the three species expected to be most abundant after H I, based on our experience with the Beta Pic gas disk. Additionally, since the disk shows sub-mm CO emission, we will observe the CO A-X absorption bands at 1419 Å, 1447 Å, 1478 Å, 1510 Å, and 1544 Å.

Our goal is to be sensitive to CS gas abundances two orders of magnitude below the Beta Pic abundances of these species. This limit was determined by comparison of the line-of-sight absorption column densities of Ca II towards the two stars. Obtaining identical spectra in two visits separated by several days will ensure that we can separate the stable gas absorption (arising from the bulk of the gas disk) from any variable gas features that might be produced by star-grazing planetesimals.

Basic Data for 49 Ceti: A1V, distance = 61 pc, B = 5.681, V = 5.619, E(B-V) = 0.03,  $F_{\text{IUE}}(@ 1800 \text{ \AA}) = 2.5 \times 10^{-11} \text{ erg s}^{-1} \text{ cm}^{-2} \text{ \AA}^{-1}$

**Observation Details:** The four orbits of this program will be divided into two identical visits of two orbits each, separated by 3 to 7 days. Since we do not require time resolution on minute scales, the STIS FUV spectra will be obtained in ACCUM mode. 49 Ceti lies in the range of restricted RA values for Cycle 20. Therefore, we have selected SCHED=100 for both visits, as required by the APT. We have verified that the total program can

be scheduled using the APT Visit Planner.

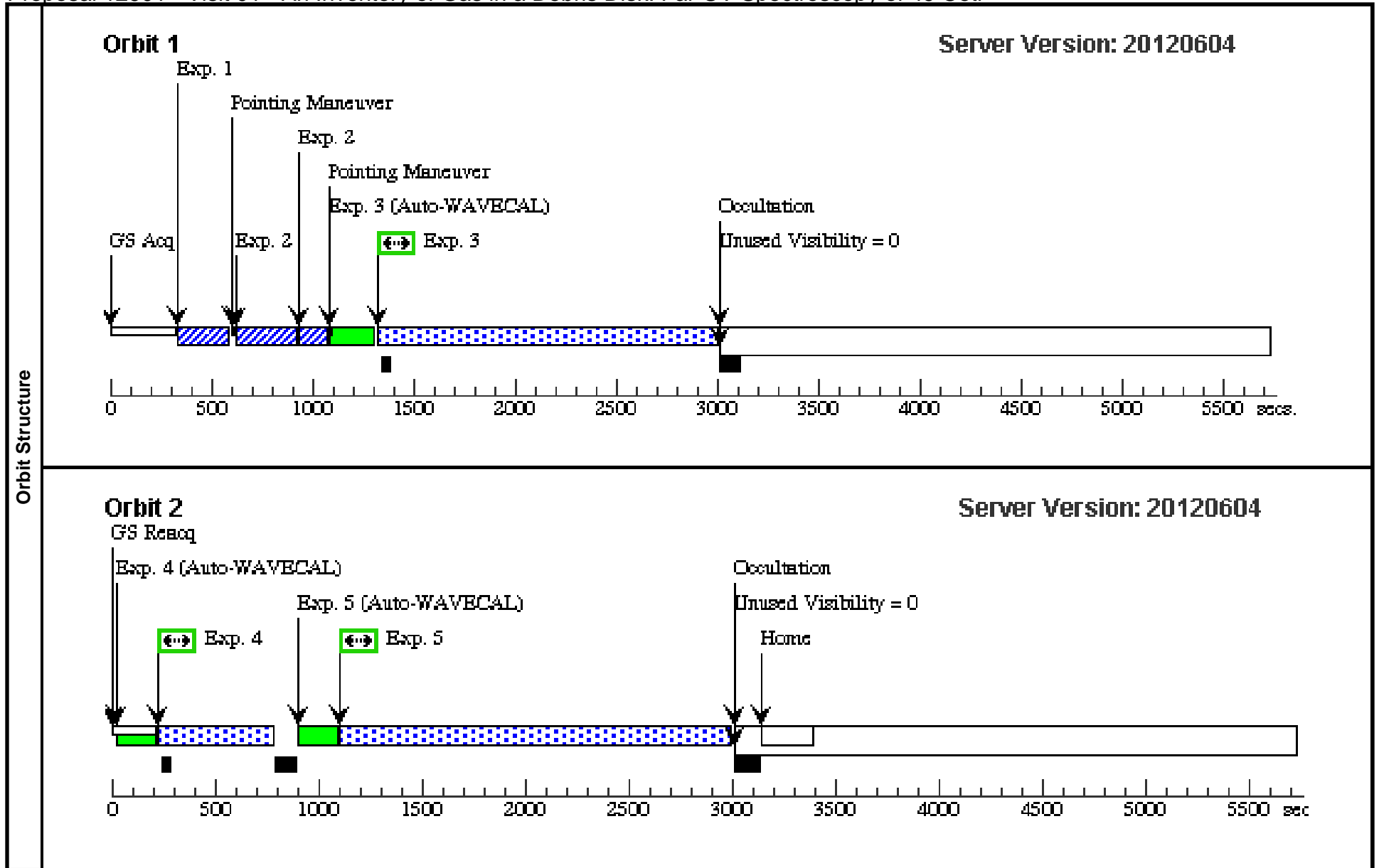
High spectral resolution is desirable for resolving multiple absorption components, allowing us to separate IS from CS gas in absorption lines arising from ground energy levels. Therefore, each visit will contain three tilts of the STIS E140H grating, providing 2.6 km/s resolution: i1271, c1416, and c1598. These spectra will cover 1170 Å to 1699 Å. Further, to get the highest spectral resolution while maintaining good throughput and to minimize terrestrial airglow contamination, we will use the narrow spectroscopic slit recommended for the high-resolution echelle gratings (0.2 arcsec x 0.09 arcsec).

Since we are using a slit narrower than 0.1 arcsec, we have included target acquisitions (ACQ) and peak-up (ACQ/PEAK) observations at the beginning of each visit. 49 Cet is a bright, isolated single star, so we will perform ACQs using the target star itself. With the F28X50LP filter, 49 Cet saturates the CCD in less than 0.1 sec. Therefore, we will use the F28X50OII filter for the ACQ observations. With this setup, the time to saturation for the ACQs is 1.17 sec and S/N = 132 is achieved in 0.1 sec. For the ACQ/PEAK observations, 49 Cet saturates the CCD in less than 0.1 sec when performing an imaging peak-up using the 0.2 arcsec x 0.09 arcsec science aperture. Therefore, we will perform imaging peak-ups using the 0.2X0.05ND slit. With this setup, the time to saturation for the ACQ/PEAKs is 0.8 sec and 60,014 total source electrons (S/N = 169) are obtained in 0.1 sec.

Proposal 12901 - Visit 01 - An Inventory of Gas in a Debris Disk: Far-UV Spectroscopy of 49 Ceti

Thu Jun 28 01:07:57 GMT 2012

Visit	<b>Proposal 12901, Visit 01</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/CCD, STIS/FUV-MAMA Special Requirements: SCHED 100%									
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous			
	(1)	49-CET	RA: 01 34 37.7788 (23.6574117d) Alt Name1: HD9672 Alt Name2: HIP7345	Dec: -15 40 34.90 (-15.67636d) Equinox: J2000	Proper Motion RA: 94.84 mas/yr Proper Motion Dec: -3.14 mas/yr Parallax: 0.01684" Epoch of Position: 2000	V=5.619	Reference Frame: ICRS			
	<i>Comments: This object was generated by the target selector and retrieved from the SIMBAD database.</i>									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	ACQ (STIS.ta.410 497)	(1) 49-CET	STIS/CCD, ACQ, F28X50OII	MIRROR	ACQTYPE=POINT			0.1 Secs [==>]	[1]
	2	ACQ/PEAK (STIS.ta.410 504)	(1) 49-CET	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.1 Secs [==>]	[1]
	3	i1271 (STIS.sp.41 0527)	(1) 49-CET	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1271 A				1663 Secs [==>]	[1]
	4	c1416 (STIS.sp.41 0528)	(1) 49-CET	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1416 A				540 Secs [==>]	[2]
	5	c1598 (STIS.sp.41 0529)	(1) 49-CET	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1598 A				1878 Secs [==>]	[2]



Proposal 12901 - Visit 02 - An Inventory of Gas in a Debris Disk: Far-UV Spectroscopy of 49 Ceti

Thu Jun 28 01:08:00 GMT 2012

Visit	<b>Proposal 12901, Visit 02</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/CCD, STIS/FUV-MAMA Special Requirements: SCHED 100%; AFTER 01 BY 3 D TO 7 D									
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous			
		(1)	49-CET Alt Name1: HD9672 Alt Name2: HIP7345	RA: 01 34 37.7788 (23.6574117d) Dec: -15 40 34.90 (-15.67636d) Equinox: J2000	Proper Motion RA: 94.84 mas/yr Proper Motion Dec: -3.14 mas/yr Parallax: 0.01684" Epoch of Position: 2000	V=5.619	Reference Frame: ICRS			
	<i>Comments: This object was generated by the target selector and retrieved from the SIMBAD database.</i>									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	ACQ (STIS.ta.410 497)	(1) 49-CET	STIS/CCD, ACQ, F28X50OII	MIRROR	ACQTYPE=POINT			0.1 Secs [==>]	[1]
	2	ACQ/PEAK (STIS.ta.410 504)	(1) 49-CET	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.1 Secs [==>]	[1]
	3	i1271 (STIS.sp.41 0527)	(1) 49-CET	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1271 A				1663 Secs [==>]	[1]
	4	c1416 (STIS.sp.41 0528)	(1) 49-CET	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1416 A				540 Secs [==>]	[2]
	5	c1598 (STIS.sp.41 0529)	(1) 49-CET	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1598 A				1878 Secs [==>]	[2]

