14731 - Si I and C I emission from zeta Aurigae (K4 Ib + B5 V): New Generation Diagnostics of Chromospheric Structure

Cycle: 24, Proposal Category: GO

(UV Initiative)

(Availability Mode: AVAILABLE)

INVESTIGATORS

Name	*Institution*	*E-Mail*
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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) -ZET-AUR WAVE	STIS/CCD STIS/NUV-MAMA	1	07-Sep-2016 18:17:52.0	yes
02	(1) -ZET-AUR WAVE	STIS/CCD STIS/NUV-MAMA	1	07-Sep-2016 18:17:53.0	yes

2 Total Orbits Used

ABSTRACT

Zeta Aur eclipsing binaries provide the most detailed spatial information about the extended atmospheres of red supergiants. During chromospheric eclipse phases quantitative information about densities, temperatures, turbulence, and ionization have been obtained. However, detailed information about the atmosphere can also be obtained away from eclipse when the hemisphere illuminated by the ultraviolet continuum of the companion is visible from Earth. New Si I and C I diagnostics can provide spatially-resolved information on the velocity fields in the deepest layers yet measured

for a K4 Ib star .

We propose to observe the zeta Aurigae system with STIS at three orbital phases to study the velocity fields and ionization balance using the Si I and C I emission feautures. zeta Aurigae has a 972 day period and the next eclipse is in March 2017. This may be the last opportunity to study this benchmark system for studying the atmospheres of cool evolved stars.

OBSERVING DESCRIPTION

In Cycle 24 we will observe the NUV spectrum of the eclipsing binary zeta Aurigae (K4 II + B5 V) on 2 separate 1 Orbit Visits. Visit 1 is during the total eclipse of the uv-bright B star, and a Visit 2 will observe both stars, out of eclipse.

NUV fluxes and Safety -

This is a UV bright binary with predictable orbital variability. The BOT identifies the target as a health warning in the GSC II, and the field was too bright for a GALEX. The stars themselves are not intrinsically variable (the B star is a main sequence star, and the K supergiant is probably a low $Delta VMag < 0.03$ amplitude), but during eclipse the system flux levels are quite different with the UV flux dropping because the B star is occulted..

To estimate the system fluxes at these 2 different orbital phases we have used several flux templates: For Visit 1 (eclipse) we have used merged IUE LW HIRES and SWP LORES spectra 1650-3200 Angstroms - whose fluxes compare closely to HST/GHRS spectral segments obtained previously. We expect these are good to 10% absolute flux calibration (the limit of IUE and GHRS spectra). For Visit 2 (maximum B star irradiation - out of eclipse) we have used both a merged IUE spectrum, and a published model B star spectrum, both flux levels agree well

The BOT flagged observations are either made with the MAMA E230H 0.2x0.09 or 31x0.05NDA apertures. During eclipse (0.2x0.09 aperture), at this time the high fluxes from the B star are reduced by an order of magnitude
- and should not thus be a health and safety risk. The out of eclipse observations in Visit 2 use the 31x0.05ND apertures. We have used the ETC for all exposure estimates (except WAVECALS).

Time Constraints-

Both Visits have time constraints that relate to the phase of the binary orbit (972 period). The 2 Visits in Cycle 24 are for the eclipse of the B star (between 2017 Mar 11-25) and an epoch where the B star irradiates the visible hemisphere of the K star (2017 Aug 10 - Oct 10). Each Visit is 1

Orbit

Observing strategy (Available)-
STIS E240H observations will provide the high spectral resolution (R > 100,000) to fully resolve the narrowest emission lines (FWHM=9.0 km/s). In both Visits will will observe the two same E230H settings (same wavelengths: i2463, i2912) with the MAMA detectors in ACCUM mode (to save time on BUFFERing).
The first WAVECAL in each Visit is required during the Orbit, but to avoid losing on-source time from the 2nd WAVECAL (i2912) we have adopted the "AVAILABLE" (but not supported mode) of explicitly specifying the wavecals. The final WAVECAL is placed at the beginning of the occultation. We have used the default expsore times
for these. "Availability Mode: AVAILABLE has been approved.

Visit 1:
ACQ/PEAK: We ACQ the K star (V=3.90) with the STIS CCD and F25ND5. We then peak-up in a 0.2x0.09 aperture with the G230L.
Science: The following MAMA E230H science observations also use 0.2x0.09 aperture.
The first 2 science observations uses the i2463Ang seeting, while the 3rd and 4th science observations will be at i2912 Ang. The use of identical pairs allows for identification of artifacts resulting from the ACCUM.

Visit 2:
ACK/PEAK we also ACQ the K star (V=3.90) with the STIS CCD and F25ND5, but because of the higher UV flux levels, we then peakup with the 31x0.05NDC with G230L.
SCIENCE: For the MAMA E230H science observations we use the 31x0.05NDA (0.4 dex) aperture+neutral density filter to keep the total count rates for the entire detector are below 70.000, below the MAMA global count rate.
The first 2 science observations uses the i2463Ang seeting, while the 3rd and 4th science observations will be at i2912 Ang. The use of identical pairs allows for the identification of artifacts resulting from the ACCUM.

*** Please note that a similar proposal from a previous cycle has adopted essentially the same ACQ/PEAK strategy (14070 PI P. Bennett) and has not yet been executed This will occur before the first scheduled Visit of this proposal.

Visit

Proposal 14731, Total Eclipse of the B star (01), implementation Wed Sep 07 22:17:54 GMT 2016

Diagnostic Status: No Diagnostics

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

Special Requirements: BETWEEN 11-MAR-2017:00:00:00 AND 25-MAR-2017:00:00:00

Comments: 2 week window around central eclipse. One could make this window a little larger if an off-centrered eclipse was OK

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	-ZET-AUR Alt Name1: HR1612	RA: 05 02 28.6874 (75.6195308d) Dec: +41 04 33.02 (41.07584d) Equinox: J2000	Proper Motion RA: 9.45 mas/yr Proper Motion Dec: -20.71 mas/yr Parallax: 0.00415" Epoch of Position: 2000.00	V=3.75+/-0.02 NUV B star continuum [for out of eclipse observations: 1.0(-10) erg cm-2 A-1 at 1700 Ang, 4x10(-11) erg cm-2 s-1 A-1 at 2 300 A, and 3.0(-11) erg cm-2 s-1 at 300 0A: Star observed at proposed wavelengths with IUE in HIRES : During eclipse the NUV fluxes are significantly less	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.This object was generated by the targetselector and retrieved from the SIMBAD database. Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Target Acq (bright K star) V=3.90 during total eclipse (STIS.ta.825531)	(1) -ZET-AUR	STIS/CCD, ACQ, F25ND5	MIRROR	ACQTYPE=POINT			4 Secs (4 Secs) *[==>]*	***[1]***

Comments: Pickles KII 3-4 model V=3.90, extinction [E(B-V)=0.08 applied before normalization.
S/N=40 for 0.29 sec, elect 4 sec observation for S/N=167. [Sat occurs at 50.77 sec]

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	ACQ/PEAK UP (STIS.sp.827125)	(1) -ZET-AUR	STIS/CCD, ACQ/PEAK, 0.2X0.09	G230LB 2375 A				3 Secs (3 Secs) *[==>]*	***[1]***

Comments: Q to Charles Proffitt on how to estimate S/N for Spectral Elements (not available in ETC). Seek > 80,000 cnt/s
[Source is too bright to used a non-dispersed light ACQ/PEAK]

Set GAIN=4 (CProffitt)

Eclipse spectrum is merge of 2 LWP HIRES and 1 SWP LORES. LWP Flux compares well with 2 GHRS regions of overlap.

Exposure time (seconds) = 1.0000 at wavelength 2600.00 Ang.
gives: SNR = 17.9390 (per resolution element)
gives: Time to Saturation (for a single exposure) = 167.64 seconds
Source only 94,375.812 cnt/s

Exposure time calculation HAD WARNINGS.
WARNING MESSAGE: "Electrons per pixel due to background (0.0095) is less than the recommended threshold of 20 electrons to avoid poor charge transfer efficiency (CTE). We suggest you consider CTE mitigation strategies described in the STIS Instrument Handbook."

Mode: spectroscopic
Detector: CCD
Central Wavelength:
Grating: [G230LB] R ~ 700
Aperture: 0.2X0.09
Gain: 4.0
 # Frames: 2
Binning: dispersion: 1, spatial: 1

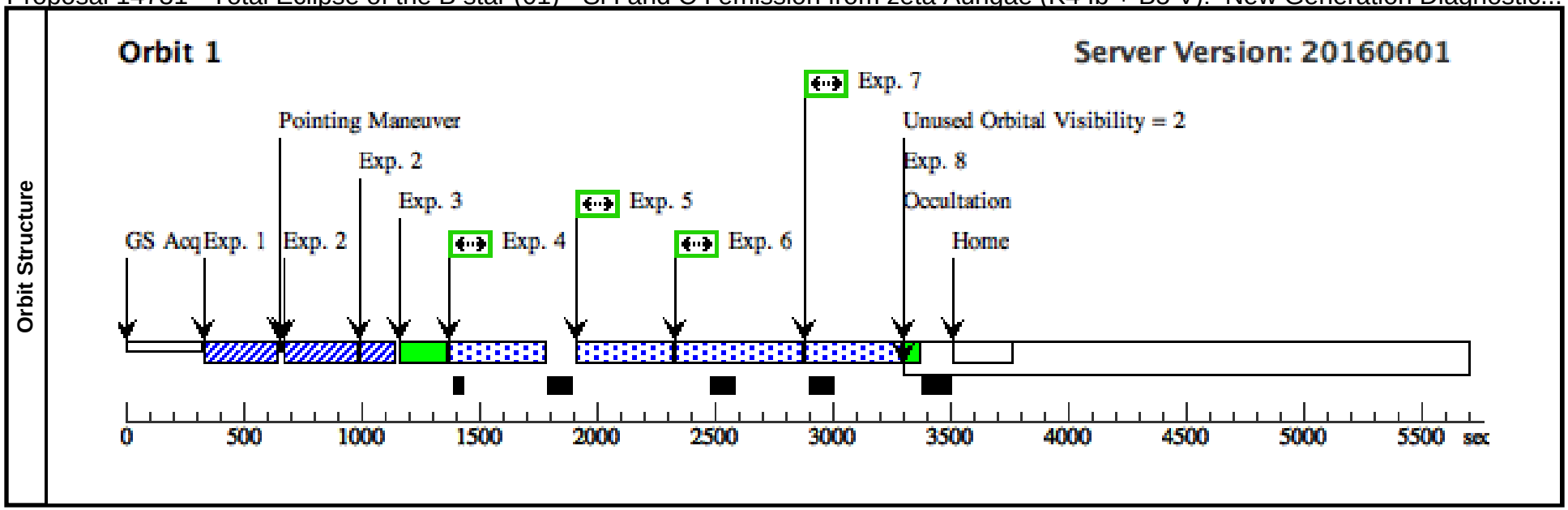
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
3	i2463 User WAVECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2463 A				*[==>]*	***[1]***
4	Total Eclipse Short (STIS.sp.827119)	(1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2463 A	WAVECAL=NO			396. Secs (396 Secs) *[==>]*	***[1]***

Comments: Observe Si I 2438, 2478., 2515, 2582 + scattered light spectrum

Exposure time (seconds) = 790.0000 at wavelength 2582.90 Ang.
gives: SNR = 15.5768 (per resolution element)

Mode: spectroscopic
Detector: NUVMAMA
Central Wavelength: 2463
Grating: [E230H] R ~ 114000
Aperture: 0.2X0.09

	5	Total Eclips e Short (STIS.sp.82 7119) (1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2463 A	WAVECAL=NO	396. Secs (396 Secs) *[==>]*	***[1]***
		Comments: Observe Si I 2438, 2478., 2515, 2582 + scattered light spectrum *Exposure time (seconds) = 790.0000 at wavelength 2582.90 Ang.* *gives: SNR = 15.5768 (per resolution element)* *Mode: spectroscopic* *Detector: NUVMAMA* *Central Wavelength: 2463* *Grating: [E230H] R ~ 114000* *Aperture: 0.2X0.09*					
	6	Total Eclips e Long (STIS.sp.82 7121) (1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2912 A	WAVECAL=NO	396. Secs (396 Secs) *[==>]*	***[1]***
		Comments: Exposure time (seconds) = 790.0000 at wavelength 2881.00 Ang.` *gives: SNR = 8.0749 (per resolution element)* *Mode: spectroscopic* *Detector: NUVMAMA* *Central Wavelength: 2912* *Grating: [E230H] R ~ 114000* *Aperture: 0.2X0.09*					
	7	Total Eclips e Long (STIS.sp.82 7121) (1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2912 A	WAVECAL=NO	396. Secs (396 Secs) *[==>]*	***[1]***
		Comments: Exposure time (seconds) = 790.0000 at wavelength 2881.00 Ang.` *gives: SNR = 8.0749 (per resolution element)* *Mode: spectroscopic* *Detector: NUVMAMA* *Central Wavelength: 2912* *Grating: [E230H] R ~ 114000* *Aperture: 0.2X0.09*					
	8	i2912 user w avecal WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2912 A		*[==>]*	***[1]***
		Comments: Exposure time based on AUTO WAVECAL					


Orbit Structure
Orbit 1
Server Version: 20160601
Exp. 7
Pointing Maneuver
Unused Orbital Visibility = 2
Exp. 2
Exp. 8
Exp. 3
Exp. 5
Occultation
GS Acq
Exp. 1
Exp. 2
Exp. 4
Exp. 6
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14731, Visit 02, implementation

Wed Sep 07 22:17:54 GMT 2016

Diagnostic Status: No Diagnostics

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

Special Requirements: BETWEEN 10-AUG-2017:00:00:00 AND 10-OCT-2017:00:00:00

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	-ZET-AUR Alt Name1: HR1612	RA: 05 02 28.6874 (75.6195308d) Dec: +41 04 33.02 (41.07584d) Equinox: J2000	Proper Motion RA: 9.45 mas/yr Proper Motion Dec: -20.71 mas/yr Parallax: 0.00415" Epoch of Position: 2000.00	V=3.75+/-0.02 NUV B star continuum [for out of eclipse observations: 1.0(-10) erg cm-2 A-1 at 1700 Ang, 4x10(-11) erg cm-2 s-1 A-1 at 2 300 A, and 3.0(-11) erg cm-2 s-1 at 300 0A: Star observed at proposed wavelengths with IUE in HIRES : During eclipse the NUV fluxes are significantly less	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.This object was generated by the targetselector and retrieved from the SIMBAD database. Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Target Acq (bright K star) V=3.90 during total eclipse (STIS.ta.825531)	(1) -ZET-AUR	STIS/CCD, ACQ, F25ND5	MIRROR	ACQTYPE=POINT			4 Secs (4 Secs) *[==>]*	***[1]***
	Comments: Pickles KII 3-4 model V=3.90, extinction [E(B-V)=0.08 applied before normalization. *S/N=40 for 0.29 sec, elect 4 sec observation for S/N=167. [Sat occurs at 50.77 sec]*								
2	ACQ/PEAK UP (STIS.sp.827129)	(1) -ZET-AUR	STIS/CCD, ACQ/PEAK, 31X0.05NDC	G230LB 2375 A				1 Secs (1 Secs) *[==>]*	***[1]***
	Comments: Q to Charles Proffitt on how to estimate S/N for Spectral Elements (not available in ETC). Seek cnt/s > 80,000 *Source is too bright to used a non-dispersed light ACQ/PEAK* *Input spectrum B star model + K4 II contribution (small) from lambda Velorom* *Exposure time (seconds) = 1.0000 at wavelength 2600.00 Ang.* *Source only 205,100.357 cnt/s* *gives: SNR = 7.1371 (per resolution element)* *gives: Time to Saturation (for a single exposure) = 648.14 seconds* *Exposure time calculation HAD WARNINGS.* *WARNING MESSAGE: "Electrons per pixel due to background (0.0095) is less than the recommended threshold of 20 electrons to avoid poor charge transfer efficiency (CTE). We suggest you consider CTE mitigation strategies described in the STIS Instrument Handbook."*								
3	i2463 user w avecal	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2463 A				*[==>]*	***[1]***
	Comments: Note we are using a smaller aperture than for the science observations (31x0.03NDA)								
4	Irradiation Max Short (STIS.sp.827190)	(1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 31X0.05NDA	E230H 2463 A	WAVECAL=NO			386 Secs (386 Secs) *[==>]*	***[1]***
	Comments: Observe Si I 2438, 2478., 2515, 2582 + scattered light spectrum *Exposure time (seconds) = 700.0000 at wavelength 2478.50 A* *gives: SNR = 48.6805 (per resolution element)* *Count rate entire detector 68,740.468* *Exposure time calculation HAD WARNINGS.* *WARNING MESSAGE: Buffer time 29.0949 is less than minimum 99 seconds.*								
5	Irradiation Max Short (STIS.sp.827190)	(1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 31X0.05NDA	E230H 2463 A	WAVECAL=NO			386. Secs (386 Secs) *[==>]*	***[1]***
	Comments: Observe Si I 2438, 2478., 2515, 2582 + scattered light spectrum *Exposure time (seconds) = 700.0000 at wavelength 2478.50 A* *gives: SNR = 48.6805 (per resolution element)* *Count rate entire detector 68,740.468* *Exposure time calculation HAD WARNINGS.* *WARNING MESSAGE: Buffer time 29.0949 is less than minimum 99 seconds.*								

6	Irradiation Max Long (STIS.sp.82 7222)	(1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 31X0.05NDA	E230H 2912 A	WAVECAL=NO	391 Secs (391 Secs) [==>]	[1]

Comments: Exposure time (seconds) = 275.0000 at wavelength 2987.60 Ang gives: SNR = 26.0580 (per resolution element)

Count rate entire detector 42,040.578

Mode: spectroscopic
Detector: NUVMAMA
Central Wavelength: 2912
Grating: [E230H] R ~ 114000
Aperture: 31X0.05NDA

7	Irradiation Max Long (STIS.sp.82 7222)	(1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 31X0.05NDA	E230H 2912 A	WAVECAL=NO	391. Secs (391 Secs) [==>]	[1]

Comments: Exposure time (seconds) = 275.0000 at wavelength 2987.60 Ang gives: SNR = 26.0580 (per resolution element)

Count rate entire detector 42,040.578

Mode: spectroscopic
Detector: NUVMAMA
Central Wavelength: 2912
Grating: [E230H] R ~ 114000
Aperture: 31X0.05NDA

8	i2912 user w avecal	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2912 A		[==>]	[1]

Comments: Using the 0.2x0.09 aperture (while science observations use the 31x0.05 NDA)

Orbit Structure