15251 - Si I and C I emission from zeta Aurigae (K4 Ib + B5 V): New Generation Diagnostics of Chromospheric Structure

Cycle: 25, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

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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	12-Jul-2017 17:09:08.0	yes

1 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.

*** In Cycle 25 we will complete this program with a single orbit Visit.

OBSERVING DESCRIPTION

In Cycle 25 we will observe the NUV spectrum of the eclipsing binary zeta Aurigae (K4 II + B5 V) out of eclipse. [This Visit is a close duplicate of the Cycle 24 14731 Visit 2]

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 $Delta V_Mag < 0.03$ amplitude). These are non-interacting stars, with only hints of wind accretion seen in the FUV.

To estimate the system fluxes at this orbital phase we have used 2 differnent flux templates: We have used a merged IUE spectrum from an out of eclipse phase, and a synthetic spectruml for the B star spectrum (based on published analysis of the system). Both flux levels agree well (10% level) with narrow GHRS spectral regions observed previously.

This is within the level of flux accurary for GHRS. For the safety checks we use the brighter model fluxes which is the Synthetic model. We have used the ETC for all exposure estimates (except WAVECALS).

Time Constraints-

The Visit has a time constraint that relates to the phase of the binary orbit (972 day period). This Visit, where the B star irradiates the visible hemisphere of the K star , should occur between 2018 July 28 - August 12. The orbit and visibility planner indicate this is possible.

Observing strategy (Available)-

STIS E230H observations will provide the high spectral resolution (R > 100,000) to fully resolve the narrowest emission lines (FWHM=9.0 km/s). We will observe two E230H settings (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) is placed at the

beginning of the occultation. We have used the default exposure times. This is now a supported mode.
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Visit 1:
ACQ: We acquire the optically bright K supergtiant star (V=3.75) with the STIS CCD and F25ND5 (and MIRROR)

ACQ/PEAK: Because of the higher flux levels in the ultraviolet where the B star contributes strongly , we then peakup with the 31x0.05NDC with G230LB (we have used the spectroscopic ETC to select the obserfing time - following advice the Cycle 24 Visits.

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, being conservative and below the MAMA global count rate for irregular variable sources.
The first 2 science observations uses the i2463Ang setting, 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 15251, Last Visit in Program (01), implementation Wed Jul 12 21:09:10 GMT 2017

Diagnostic Status: No Diagnostics

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

Special Requirements: BETWEEN 28-JUL-2018:00:00:00 AND 12-AUG-2018:00:00:00

Comments: Thie technical details of this Visit should be very similar to Visit 2 of Cycle 24 (14731). The difference is related in time to a difference phase of binary orbit. In both cases we are observing both the B star and K star.

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	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=3.75 (STIS.ta.100 5923)	(1) -ZET-AUR	STIS/CCD, ACQ, F25ND5	MIRROR	ACQTYPE=POINT			4 Secs (4 Secs) *[==>]*	***[1]***
	Comments: Pickles KII 3-4 model V=3.75, extinction [E(B-V)=0.08 applied before normalization. *S/N=40 for 0.25 sec, elect a 4 sec observation for S/N=179. [Sat occurs at 44 sec]*								
2	ACQ/PEAK UP (STIS.sp.10 05929)	(1) -ZET-AUR	STIS/CCD, ACQ/PEAK, 31X0.05NDC	G230LB 2375 A				1 Secs (1 Secs) *[==>]*	***[1]***
	Comments: Q to Charles Proffitt (2016) 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* *GAIN = 4* *Exposure time (seconds) = 1.0000 at wavelength 2375.00 Ang.* *Source only 202,002 cnt/s* *gives: SNR = 7.4 (per resolution element)* *gives: Time to Saturation (for a single exposure) = 182 seconds* *Exposure time calculation HAD WARNINGS.* *WARNING MESSAGE: "Electrons per pixel due to background (0.009) 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 WAV ECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2463 A				*[==>]*	***[1]***
4	Model Diffe rence Short (STIS.sp.10 06674)	(1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 31X0.05NDA	E230H 2463 A	WAVECAL=NO			386 Secs (394 Secs) *[==>394.0 Secs]*	***[1]***
	Comments: Observe B star + K star Si I 2438, 2478., 2515, 2582 + scattered light spectrum *Exposure time (seconds) = 380.0000 at wavelength 2463 A* *gives: SNR = 36.7 (per resolution element)* *Count rate entire detector 69297 s-1* *Exposure time calculation HAD WARNINGS.* *WARNING MESSAGE: Buffer time 29.0949 is less than minimum 99 seconds.*								
5	Model Diffe rence Short (STIS.sp.10 06674)	(1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 31X0.05NDA	E230H 2463 A	WAVECAL=NO			386. Secs (394 Secs) *[==>394.0 Secs]*	***[1]***
	Comments: Observe Si I 2438, 2478., 2515, 2582 + scattered light spectrum *Exposure time (seconds) = 380.0000 at wavelength 2463.00A* *gives: SNR = 36.7 (per resolution element)* *Count rate entire detector 69,297.2* *Exposure time calculation HAD WARNINGS.* *WARNING MESSAGE: Buffer time 28.86 is less than minimum 99 seconds.*								

6	Model Difference Long (STIS.sp.10 06680)	(1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 31X0.05NDA	E230H 2912 A	WAVECAL=NO	391 Secs (399 Secs) *[==>399.0 Secs]*
	Comments: Exposure time (seconds) = 380.0000 at wavelength 2987.60 Ang gives: SNR = 30.5 (per resolution element) *Count rate entire detector 41,622.2* *Mode: spectroscopic* *Detector: NUVMAMA* *Central Wavelength: 2912* *Grating: [E230H] R ~ 114000* *Aperture: 31X0.05NDA*					
7	Model Difference Long (STIS.sp.10 06680)	(1) -ZET-AUR	STIS/NUV-MAMA, ACCUM, 31X0.05NDA	E230H 2912 A	WAVECAL=NO	350 Secs (358 Secs) *[==>358.0 Secs]*
	Comments: Exposure time (seconds) = 380.0000 at wavelength 2987.60 Ang gives: SNR = 30.5 (per resolution element) *Count rate entire detector 41,662/2* *Mode: spectroscopic* *Detector: NUVMAMA* *Central Wavelength: 2912* *Grating: [E230H] R ~ 114000* *Aperture: 31X0.05NDA*					
8	i2912 WAVECAL (during occultation)	WAV WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2912 A		*[==>]*
	Comments: Using 0.2x0.09 aperture (while science observation uses 31x0.05 arcsec)					

Orbit Structure