	SOUTHERN AFRICAN LARGE TELESCOPE **PHASE 1 OBSERVING TIME APPLICATION**

Year	2014	**Semester *(1 = 1 May-31 Oct; 2 = 1 Nov-30 Apr)***	1	**Code**	Unsubmitted-001

1. TITLE
Spectroscopic Observations of Three Cataclysmic Variables at Varying Inclinations

2. PRINCIPAL INVESTIGATOR Surname, First Name(s) of the PI	**Affiliation**	**PI Partner (standard code)**	**Time Requested From Partner (sec)**
Matthews, James	Southampton University	UKSC	4266

3. Co-INVESTIGATORS Surname, First Name(s) of the Co-I	**Affiliation**	**Co-I Partner (standard code)**	**Time Requested from Partner (sec)**
Knigge, Christian	Southampton University	UKSC	

4. PRINCIPAL CONTACT Surname, First Name(s) of the PC	**AFFILIATION**	**Email Address & Telephone Number**
Matthews, James	Southampton University	jm8g08@soton.ac.uk +447933139071

5. WILL THIS FORM PART OF A STUDENT THESIS ?	No

6. IS THIS SUPPORTED EXTERNALLY ?	Yes
Source of funding	STFC

7. ABSTRACT

We have recently obtained results, using Monte Carlo radiative transfer techniques, which show that accretion disk winds can have a major effect on optical spectra of Cataclysmic variables (CVs). CVs are systems in which a white dwarf accretes matter from a donor star via Roche-lobe overflow. We propose spectroscopic observations of three `simple-disk' CVs which, in symbiosis with our detailed radiative transfer simulations, will enable us to gain a better understanding of CV optical spectra and the true nature of the accretion disk winds in such objects. These observations are extremely modest in time demands, and for that reason, coupled with the recent nature of our results we submit a Priority 4 proposal beyond the normal deadline in the hope that it will be considered as a good `filler' program which will not interfere with other science.

8. NUMBER OF TARGETS, TOTAL OBSERVING TIME, TOO or TIME CRITICAL			
Number of Targets/Fields	3	**Requested Bright Time (sec)**	0
Target of Opportunity?	No	**Requested Gray Time (sec)**	0
Time Critical Observation?	No	**Requested Dark Time (sec)**	2133
		Requested Any Time (sec)	2133
Minimum Useful Time (sec)	2133	**Total Requested Time (sec)**	4266

9. MINIMUM OBSERVING CONDITIONS REQUIRED			
Sky Brightness	See target information	**Maximum tolerable seeing**	5.0"
Transparency Requirements	Non-photometric	**Degree of cloud**	Any
Description	No constraints.		

10. INSTRUMENT CONFIGURATIONS REQUESTED
RSS longslit spectroscopy; 2300 l/mm; full frame

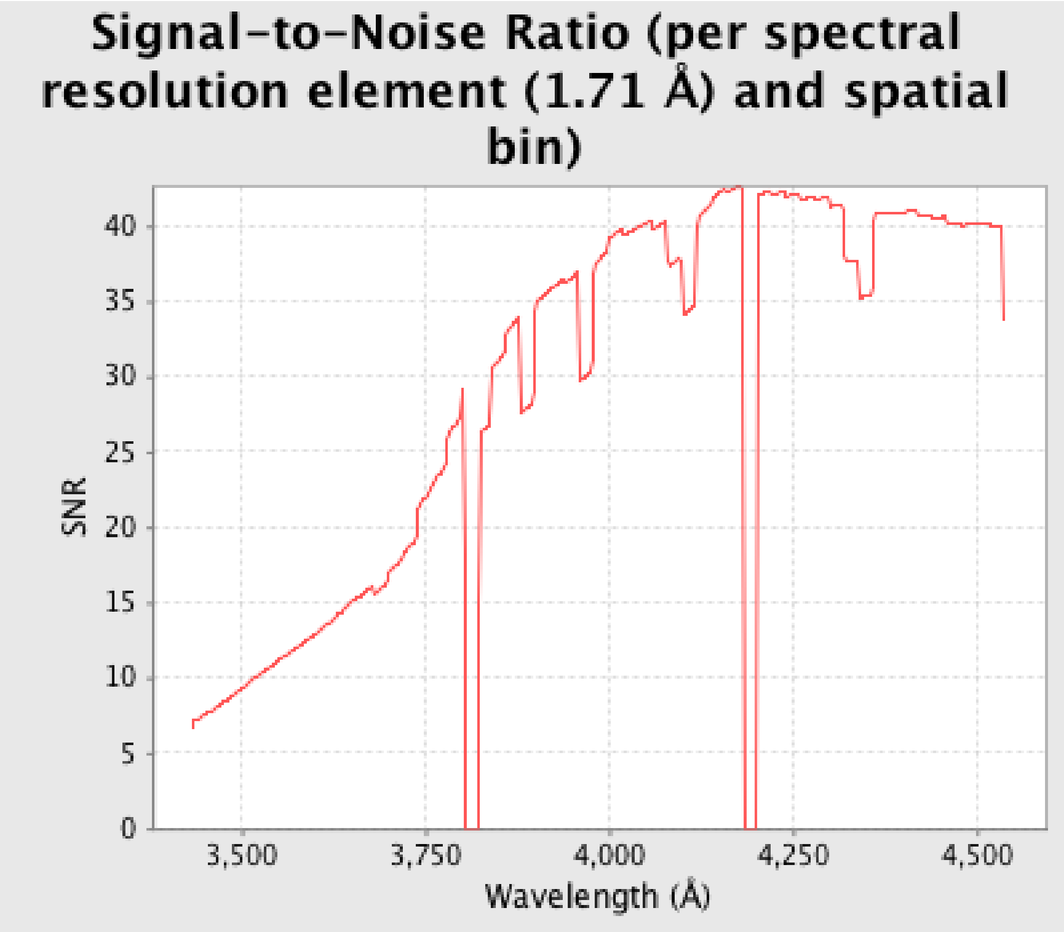
11. TARGET INFORMATION						
Mandatory Targets (all are requested to be observed)						
Object Name	***R.A. (J2000)***	***Dec (J2000)***	***Mag. (Filter)***	***Obs. Time (sec)***	***Moon***	***Ranking***
IX Vel	08h 15m 19s	-49° 13' 22"	9.0 (V) to 10.5 (V)	704	Any	High
RW Sex	10h 19m 57s	-08° 41' 56"	9.9 (V) to 12.1 (V)	704	Any	High
UU Aqr	22h 09m 06s	-03° 46' 18"	13.3 (V) to 15.5 (V)	725	Any	High
Total Time/Range	*08h 15m to 22h 09m*	*-49° 13' to -03° 46'*	*9.0 (V) to 15.5 (V)*	*2133*	*Dark to Bright*	*High*
Optional Targets (a subset of any N = 0 targets are requested to be observed from the following list)						
There are no optional targets in the proposal.						

12. TRACK INFORMATION									
Mandatory Targets (all are requested to be observed)									
Object Name	***Max. Track (sec)***	***Number of Nights***				***Number of Tracks***			
		Dark	***Gray***	***Bright***	***Any***	***Dark***	***Gray***	***Bright***	***Any***
IX Vel	4328	23	8	6	44	23	8	6	44
RW Sex	3851	16	4	11	38	16	4	11	38
UU Aqr	3494	145	47	34	238	99	38	26	147
Optional Targets (a subset of any N = 0 targets are requested to be observed from the following list)									
There are no optional targets in the proposal.									

13. PREVIOUS PROPOSALS
There is no information regarding previous proposals.

14. INSTRUMENT SIMULATIONS
Simulation 1: UU Aqr Blue
Comments Blue end of UU Aqr spectrum.
Setup diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 12.7 sec
Target magnitudes (diffuse flux) U: 12.7, B: 13.2, V: 13.3, R: 13.4, I: 13.4

SNR



Simulation 2: UU Aqr Mid-Blue

Comments

Mid-blue end of UU Aqr spectrum.

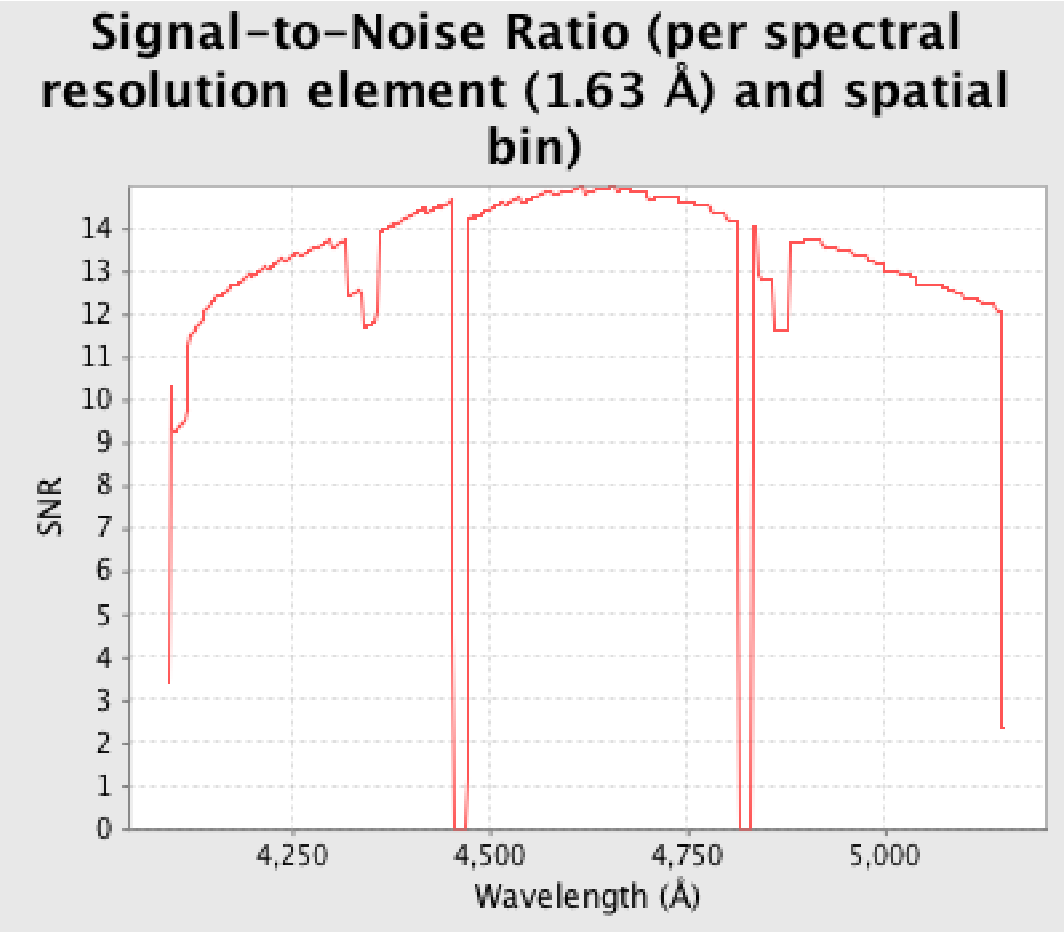
Setup

diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 1.7 sec

Target magnitudes (diffuse flux)

U: 12.7, B: 13.2, V: 13.3, R: 13.4, I: 13.4

SNR



Simulation 3: UU Aqr Mid-Red

Comments

Mid-red end of UU Aqr spectrum.

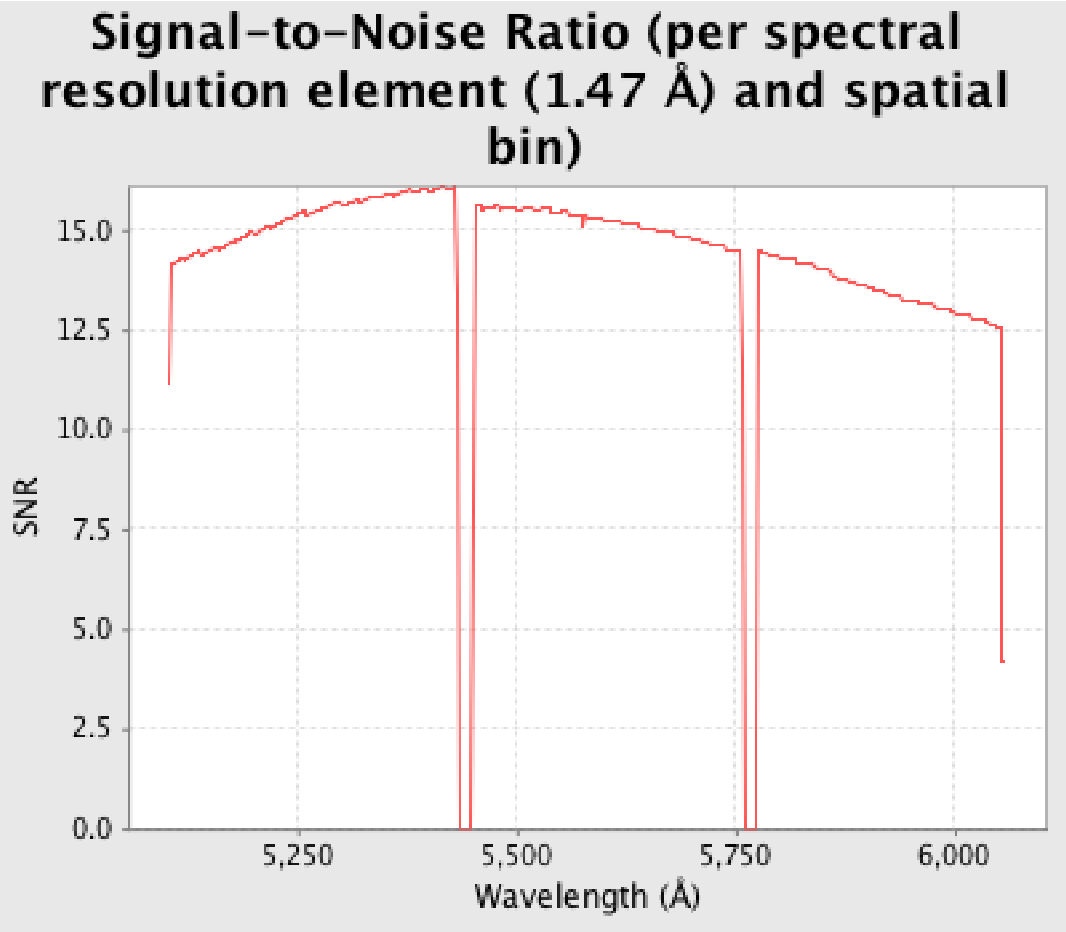
Setup

diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 2.5 sec

Target magnitudes (diffuse flux)

U: 12.7, B: 13.2, V: 13.3, R: 13.4, I: 13.4

SNR



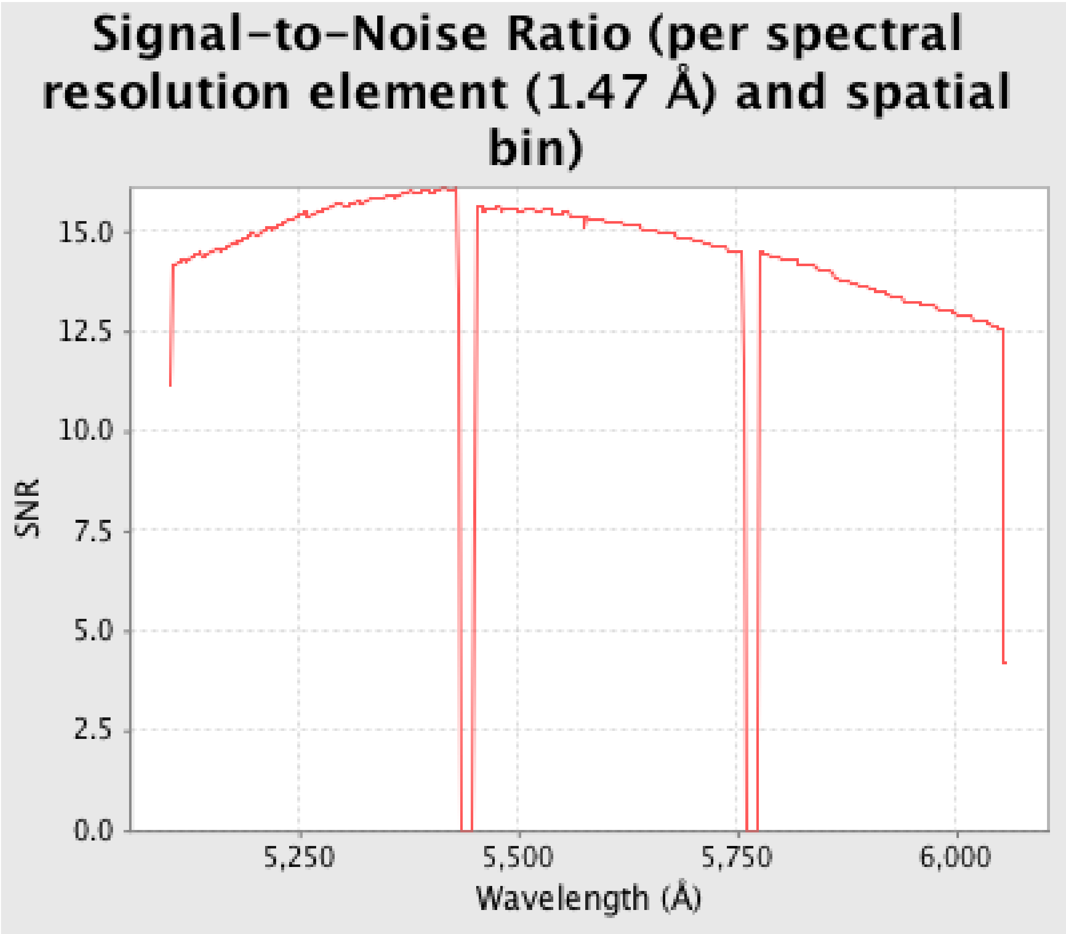
Simulation 4: UU Aqr Red

Comments
Red end of UU Aqr spectrum.

Setup
diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 2.5 sec

Target magnitudes (diffuse flux)
U: 12.7, B: 13.2, V: 13.3, R: 13.4, I: 13.4

SNR



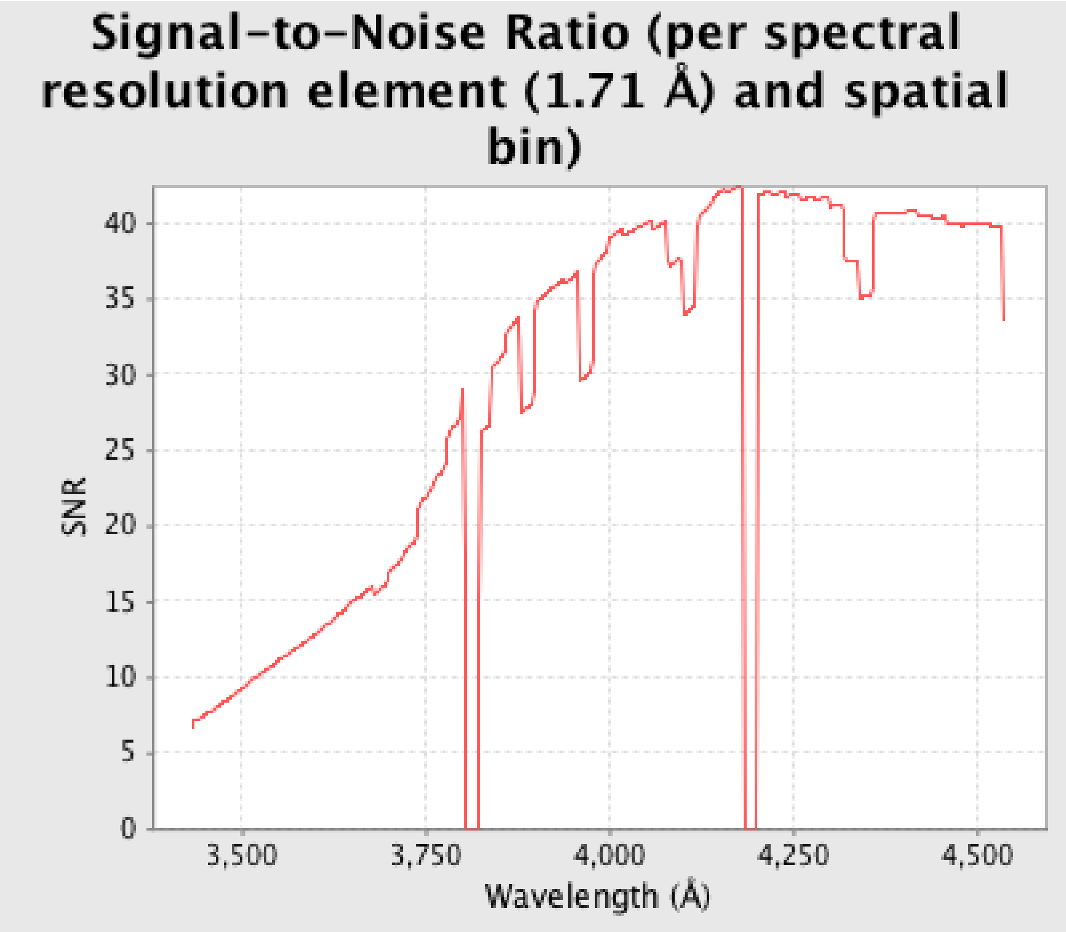
Simulation 5: IX Vel Blue

Comments
Blue end of IX Vel spectrum.

Setup
diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 0.2 sec

Target magnitudes (diffuse flux)
U: 8.4, B: 8.9, V: 9.0, R: 9.1, I: 9.1

SNR



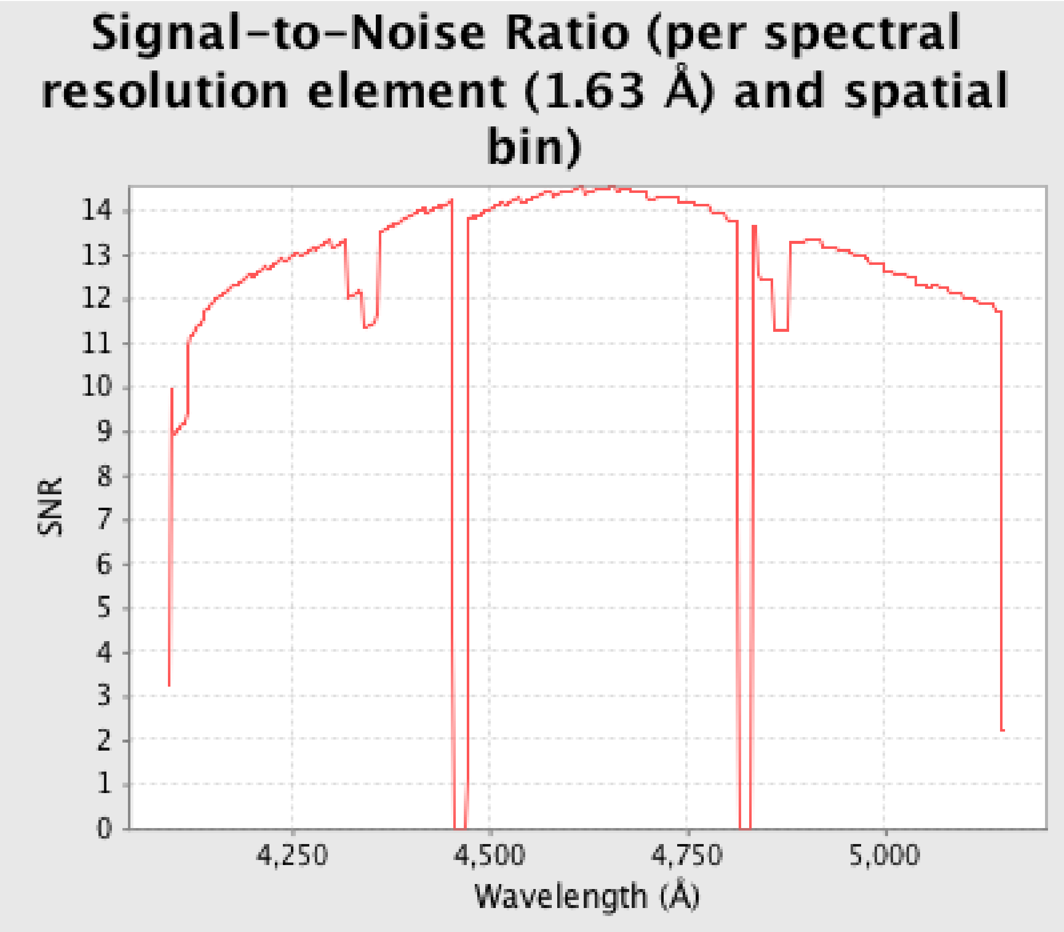
Simulation 6: IX Vel Mid-Blue

Comments
Mid-Blue end of IX Vel spectrum.

Setup
diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 0.0 sec

Target magnitudes (diffuse flux)
U: 8.4, B: 8.9, V: 9.0, R: 9.1, I: 9.1

SNR



Simulation 7: IX Vel Mid-Red

Comments

Mid-Red end of IX Vel spectrum.

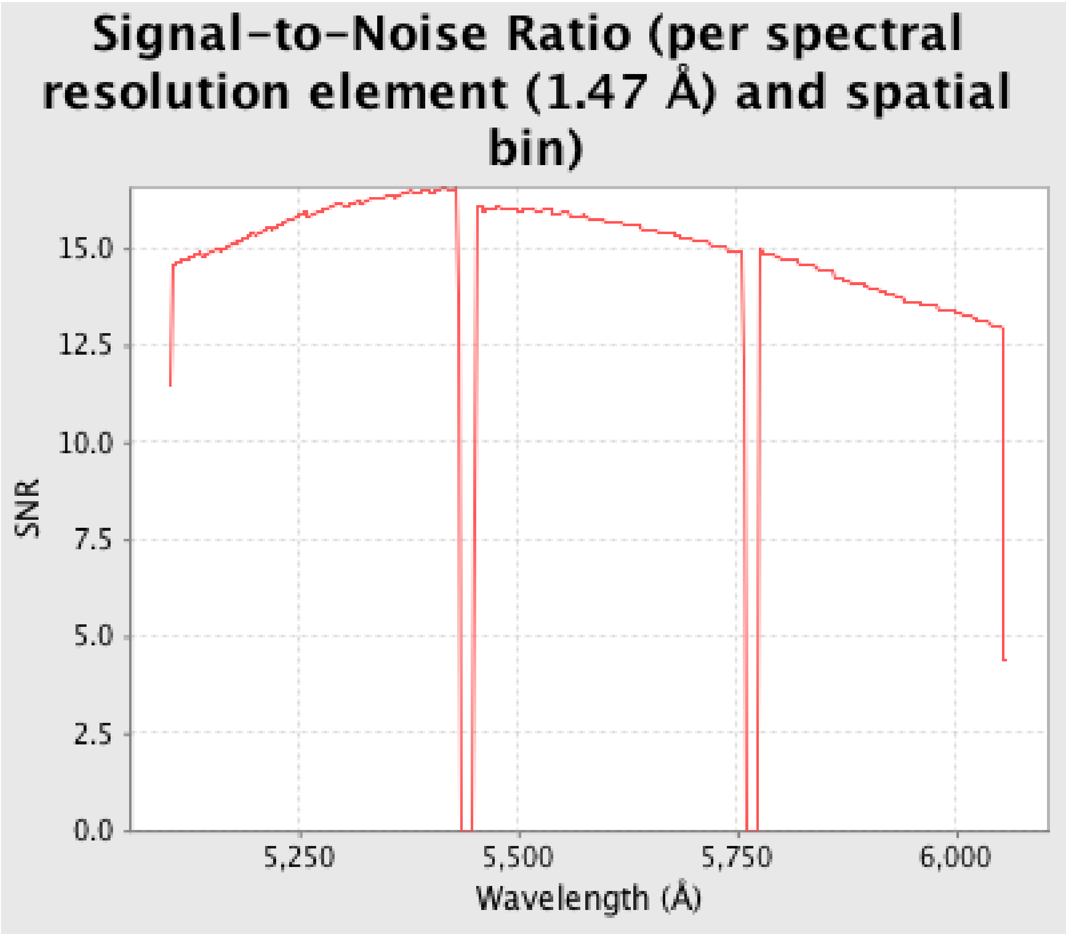
Setup

diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 0.1 sec

Target magnitudes (diffuse flux)

U: 8.4, B: 8.9, V: 9.0, R: 9.1, I: 9.1

SNR



Simulation 8: IX Vel Red

Comments

Red end of IX Vel spectrum.

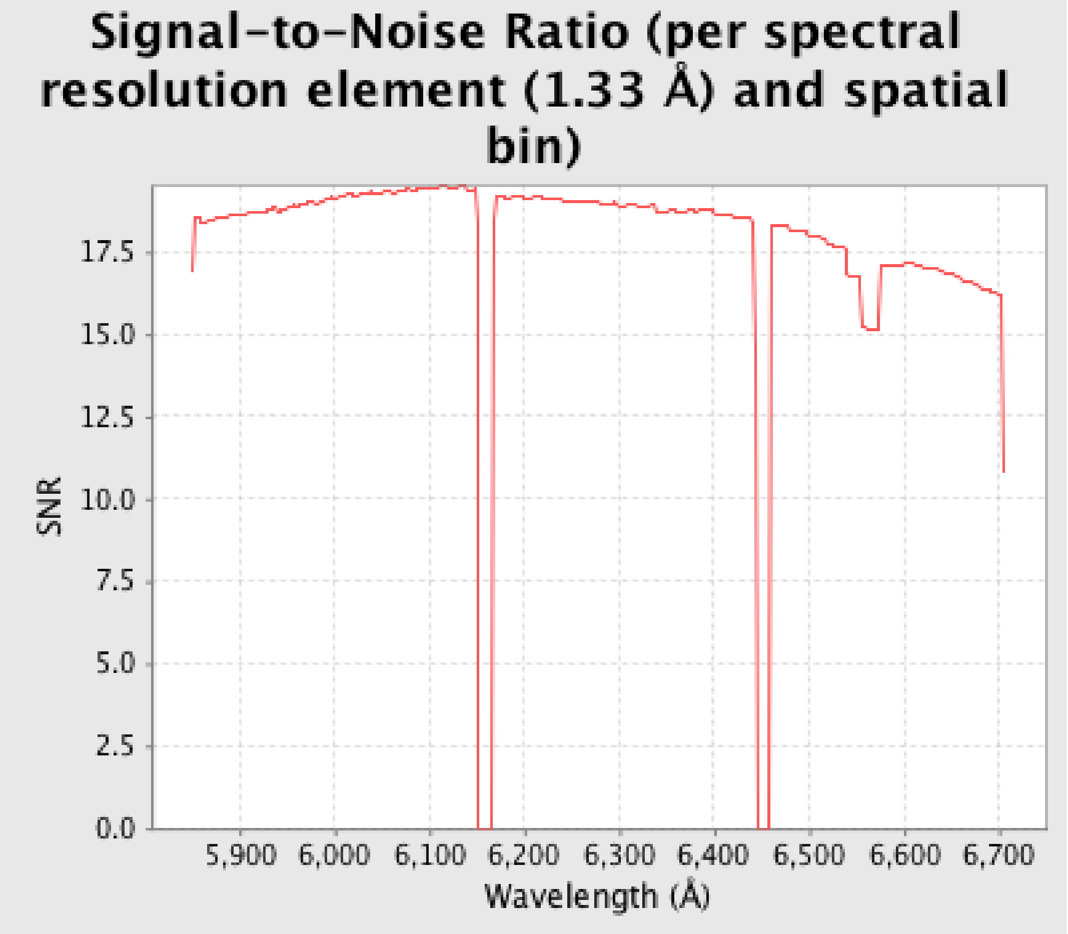
Setup

diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 0.1 sec

Target magnitudes (diffuse flux)

U: 8.4, B: 8.9, V: 9.0, R: 9.1, I: 9.1

SNR



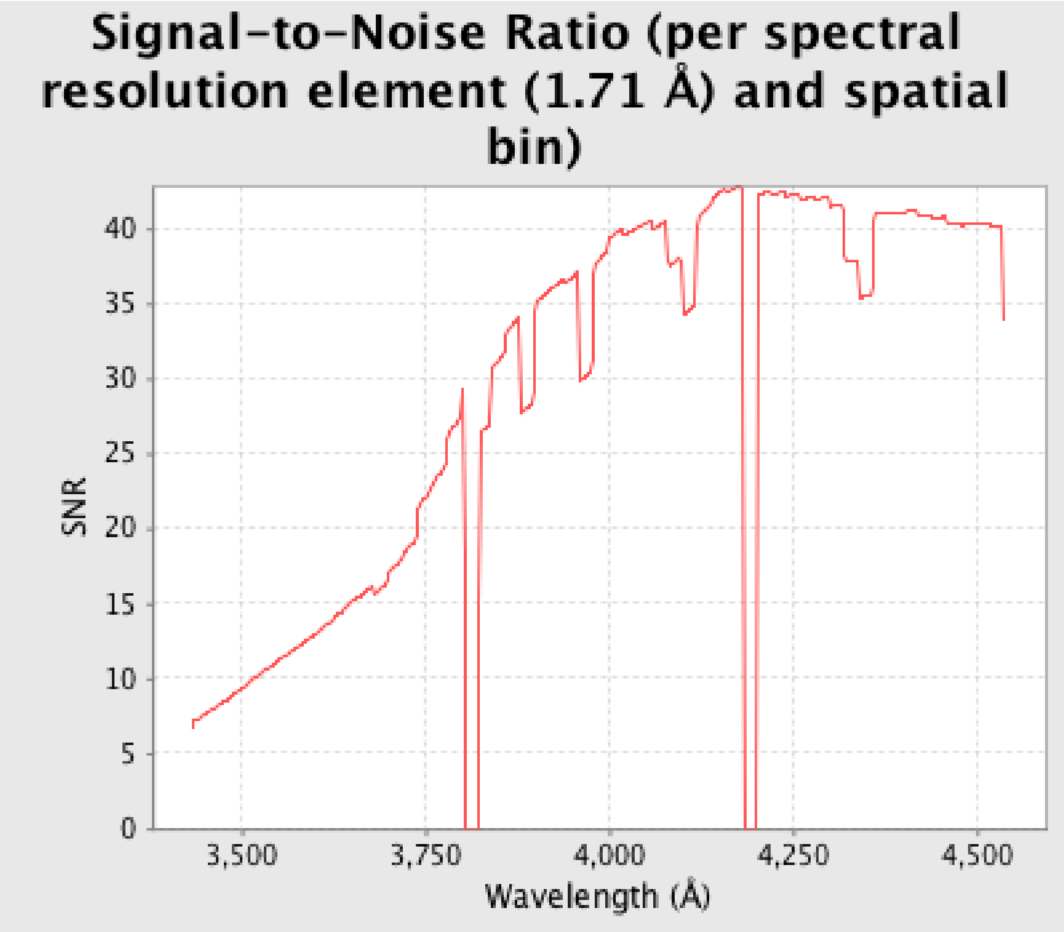
Simulation 9: RW Sex Blue

Comments
Blue end of RW Sex spectrum.

Setup
diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 0.6 sec

Target magnitudes (diffuse flux)
U: 9.3, B: 9.8, V: 9.9, R: 10.0, I: 10.0

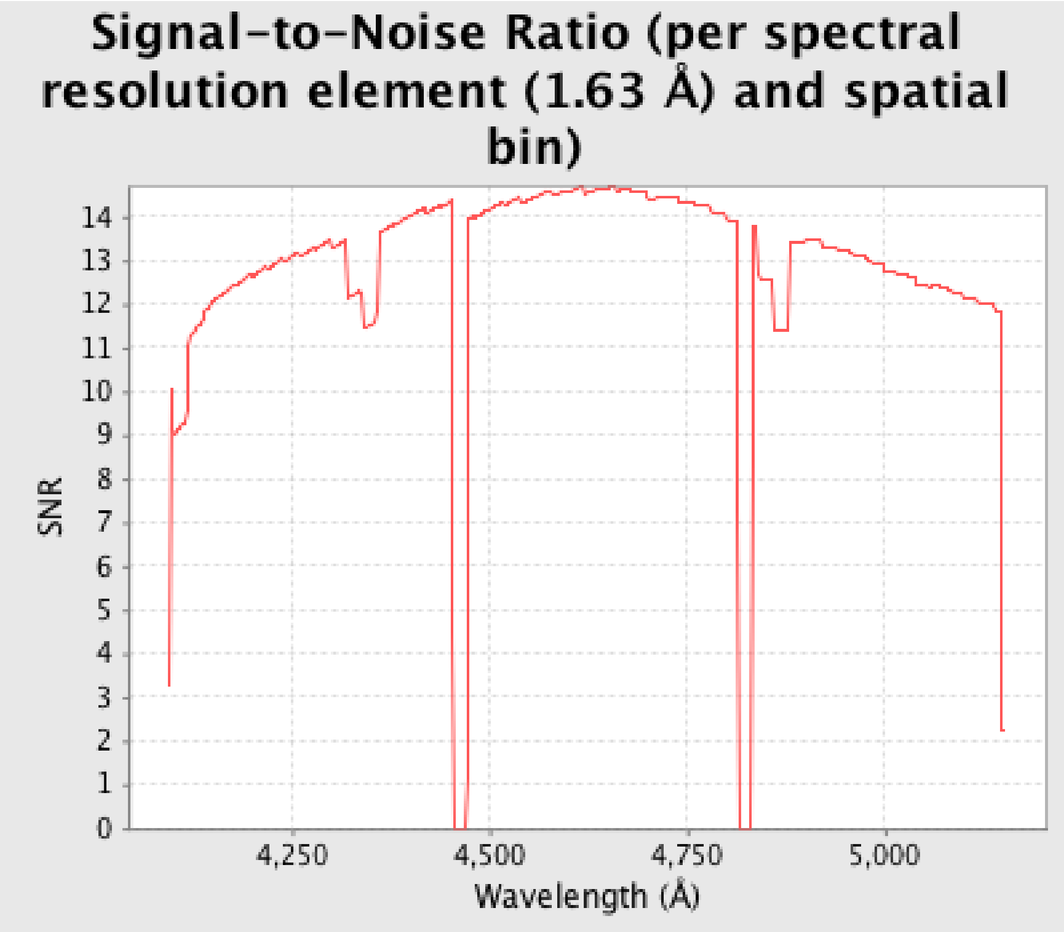
SNR



Simulation 10: RW Sex Mid-Blue

Comments Mid-Blue end of RW Sex spectrum.
Setup diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 0.1 sec
Target magnitudes (diffuse flux) U: 9.3, B: 9.8, V: 9.9, R: 10.0, I: 10.0

SNR



Simulation 11: RW Sex Mid-Red

Comments

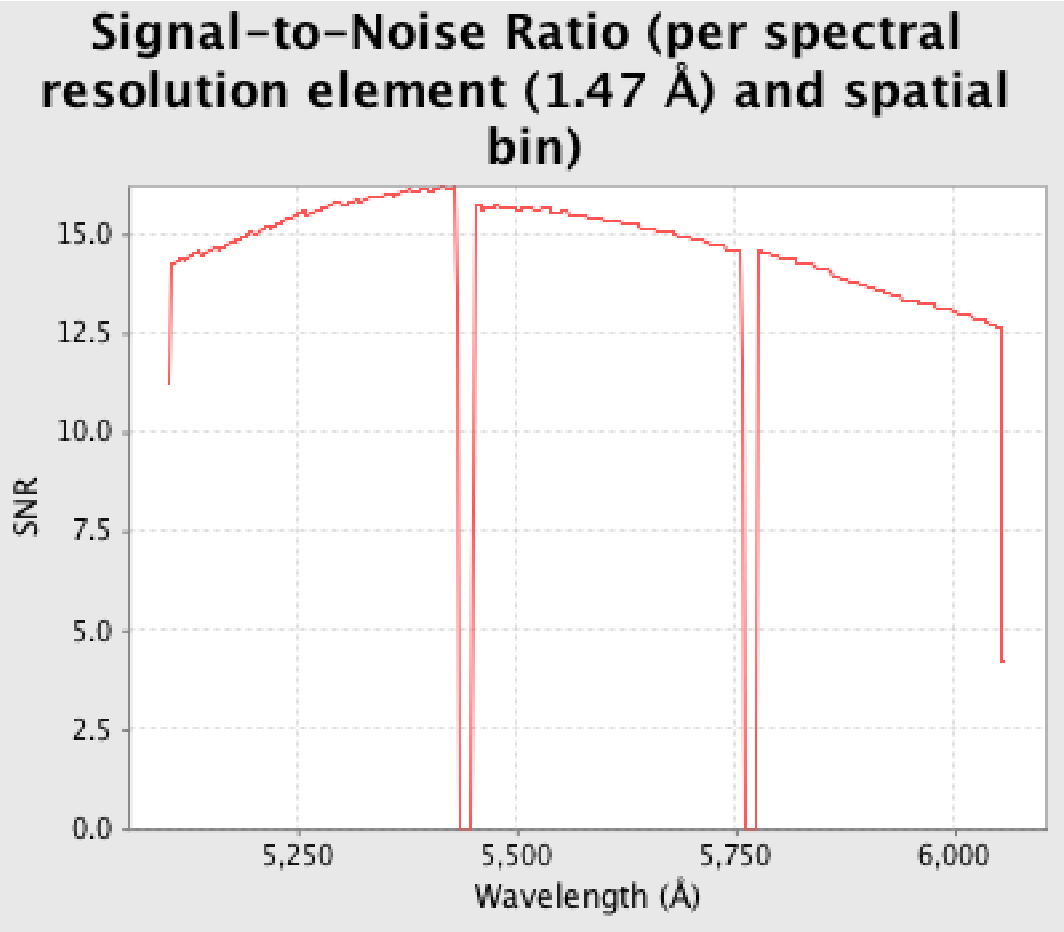
Mid-Red end of RW Sex spectrum.

Setup

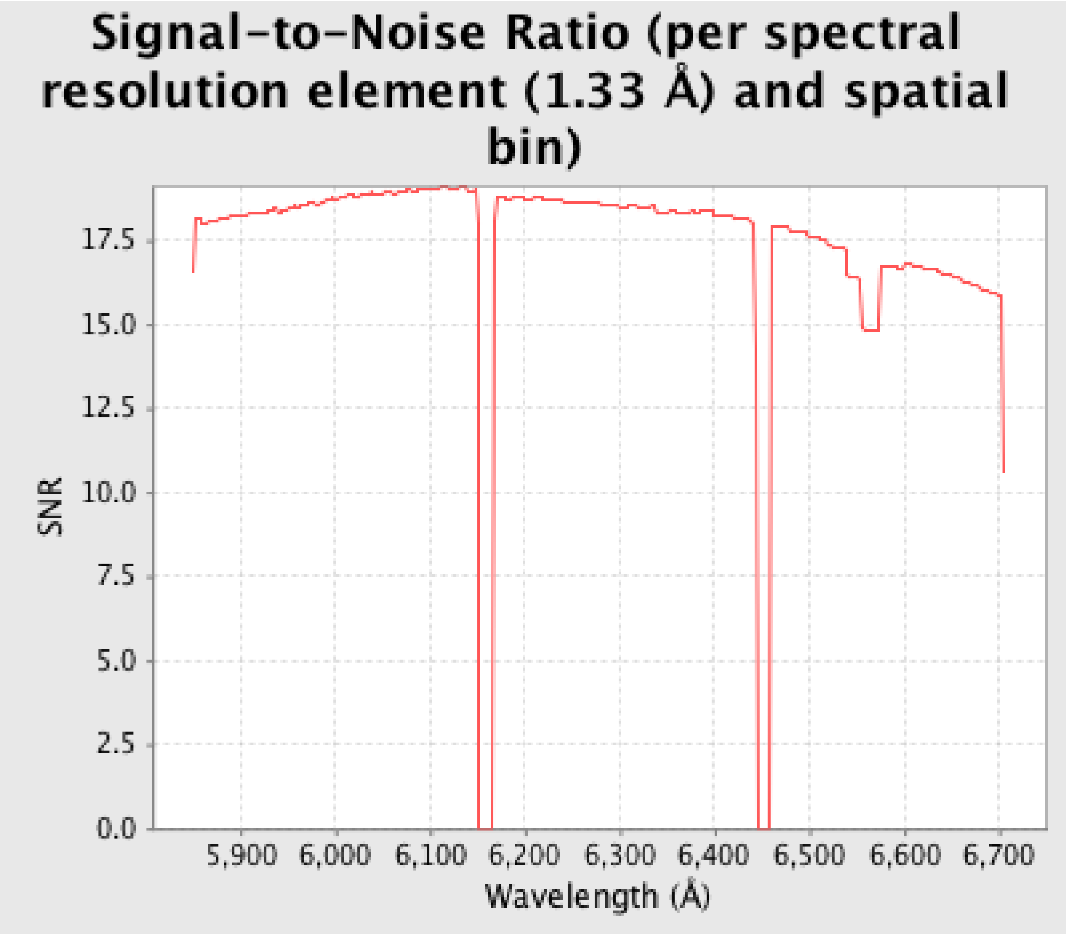
diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 0.1 sec

Target magnitudes (diffuse flux)

U: 9.3, B: 9.8, V: 9.9, R: 10.0, I: 10.0

SNR 
 Simulation 12: RW Sex Red
Comments Red end of RW Sex spectrum.
Setup diffuse flux; seeing 5.0 arcsec; bright Moon; RSS longslit spectroscopy (1.3 arcsec); 2300 l/mm; full frame; exposure time 0.2 sec
Target magnitudes (diffuse flux) U: 9.3, B: 9.8, V: 9.9, R: 10.0, I: 10.0

SNR


Signal-to-Noise Ratio (per spectral resolution element (1.33 Å) and spatial bin)
SNR
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
5,900
6,000
6,100
6,200
6,300
6,400
6,500
6,600
6,700
Wavelength (Å)

The following sections have been generated by the PI. The total page limit for these sections is 4 × A4 pages. Font size should not be less than 10 points.

15. SCIENTIFIC RATIONALE

This section needs to discuss the scientific background and aims of the proposal and why you want to make these observations. This section should not exceed 1000 words. Figures and graphics can be included, or appended in Section 18.

In the last few weeks, our team has used a Monte Carlo radiative transfer code to show that accretion disk winds can have a profound impact on the optical spectra of Cataclysmic Variables (CVs). Here we propose a set of spectroscopic observations of three CVs, with our motivation for submitting past the deadline being due to the following key points:

- *The results which have led to this proposal have been* **very** *recently obtained.*
- *Due to the brightness of the objects, the observations are extremely cheap; we estimate a combined total of 30 minutes for the three objects in question to obtain signal-to-noise ratios of 30+.*
- *The data will be made publicly available, and serve as something of an online 'atlas' for the CV community.*
- *The spectra are required because broadband, single epoch spectroscopy of the systems in question is not currently available to the required spectral resolution.*

Cataclysmic variables are systems in which a white dwarf accretes matter from a donor star via Roche-lobe overflow. In non-magnetic nova-like systems (NMNLs) this accretion is mediated by an accretion disk which forms around the white dwarf, and emits in the optical and ultraviolet. NMNLs act as the perfect laboratory for accretion physics and testing of the 'simple' disk model proposed by Shakura & Sunyaev (1972), with one specific example being the testing of the predicted $T \propto R^{-3/4}$ temperature profile with eclipse mapping (Rutten, van Paradijs & Tinbergen 1992).

For over three decades, it has been known that winds emanating from the accretion disk are important in shaping the ultraviolet spectra of CVs (Heap 1978), the most spectacular evidence being the P-Cygni like profiles of resonance lines such as C IV (see e.g. Cordova & Mason 1982). However, the extent to which winds influence optical spectra is not known, and even their origin and driving mechanism remains unclear (Drew & Proga 2000). Answering these questions has far reaching implications, as disk winds are of astrophysical importance across many orders of magnitudes in mass. They are proposed as an important mechanism for AGN feedback (Silk & Rees 1998) and shaping the spectra of Quasars (Weymann et al. 1991), and understanding them is vital to test unification of accreting objects.

Our recent Monte Carlo radiative transfer simulations (Matthews et al., in prep) expand on the work of Long & Knigge (2002) by incorporating line transfer techniques suggested by Lucy (2002, 2003). Excitingly, these improvements have enabled us to show that the same outflow models used to explain the ultraviolet features seen in CVs also have a significant impact on optical features. In particular, we find that recombination lines in Hydrogen and Helium can be produced by a disk wind, and the same wind geometry can 'fill in' the Balmer absorption edge that has thus far been present in CV models (but not observations; see e.g. Knigge & Drew 1997). An example synthesized spectrum can be seen in Figure 1.

We propose a spectroscopic study of three classic high-state systems at different inclinations. **RW Sextantis, IX Velorium** and **UU Aquarii** are all simple disk CVs with high accretion rates, and hence also have potential for mass loss. At inclinations of $\sim 30°$, $\sim 60°$ and $\sim 80°$ respectively these three objects provide opportunities to probe spectra across the full range of viewing angles.

These observations are essential for validating our results and will provide a useful resource to the community. They are required because sufficient quality spectra of NMNLs at varying inclinations are not available, and SALT's spectral capabilities provide the perfect opportunity to observe these objects. In symbiosis with our modeling, the analysis of these spectra will help us to draw conclusions about the nature of the Balmer jump, the recombination lines of H and He and the continuity between disk atmosphere and disk wind. This will provide answers of astrophysical importance from a relatively modest time investment, and will also result in prompt publication for maximum benefit to the community.

16. IMMEDIATE OBJECTIVES

This section needs to present the plan of how you will use the data you will gather to achieve the science goals set out above. There is a 250 word limit.

Our objective is to use the wide-band spectrum for direct comparison with our radiative transfer simulations. By obtaining spectra at a variety of inclinations we will be able to test for the presence or otherwise of a Balmer jump in emission or absorption, discover trends in line emission strengths and profile shapes across the Balmer series, and assess the Helium emission. Combined with our theoretical work, this will provide a unique insight into how much the disk wind affects the optical spectra of CVs.

17. DATA REQUIREMENTS FOR PROPOSAL COMPLETION

This section should explain what (if any) other observations are needed to complete the science objectives. If time is requested for more than one semester, the justification should be here. There is a 100 word limit.

Broadband optical spectra, as described in the technical justification, for all three objects: RW Sextantis, IX Velorium and UU Aquarii.

18. TECHNICAL JUSTIFICATION

This section should be limited to 500 words and needs to clearly demonstrate that you have used the SALT instrument simulation tools to find a configuration which makes sense and matches your science goals, including the S/N required. It needs to verbalize the overall observing strategy and to demonstrate that you understand the overheads involved in the observations and hence a justification of the total time requested.

In their normal state, RW Sextantis, IX Velorium and UU Aquarii have optical V band magnitudes of 9.9, 9.0 and 13.3 respectively (Ritter & Kolb 2003). We require SNR $\geq$ 30 for all objects, but fortunately this is easily achievable with time budgets still being dominated by overheads. In total, we estimate 198.3 seconds of total time (exposure plus overheads) for UU Aqr, and ?? and ?? for RW Sex and IX Vel respectively.
We will be using RSS in long slit mode. Will will use the pg2300 grating which provides coverage from ??? to ??? with a high enough spectral resolution. We suggest the following grating angles, to be repeated for **each** observation

- Camera Station 60.25°, Grating angle 48.875°. Simulation file uuaqr_blue.rsim.
- Camera Station 70.75°, Grating angle 29.375°. Simulation file uuaqr_mid.rsim.
- Camera Station 85.0°, Grating angle 39.125°. Simulation file uuaqr_mid2.rsim.
- Camera Station 98.5°, Grating angle 49.25°. Simulation file uuaqr_red.rsim.

These grating settings provide coverage from $\lambda 3505\text{Å} - \lambda 6949\text{Å}$. This set of observations has a combined exposure time of ?? and overheads of ?? leading to a total ?? of time, and obtains SNR $\geq$ 30 for all observations, and SNR $\sim$ 100 in the majority of cases.

19. ROLE OF THE PI

This section, which is only required if you request time from the South African TAC, should describe the role the PI will have in the project other than proposing and being a co-author on the proposal and the published paper.

The PI will liase with the Co-Is and SA.

20. REFERENCES

A list of all relevant references.

Cordova & Mason, 1982, ApJ, 260, 716
Drew & Proga 2000, NewA Rev., 44, 21
Long & Knigge 2002, ApJ, 579, 725
Lucy 2003, A&A, 403, 261
Ritter & Kolb 2003, A&A, 404, 301
Shakura & Sunyaev 1973, A&A, 24, 337
Weymann et al. 1991, ApJ, 373, 23
Dhillon 1996, IAU Colloq. 158: 208, 3
Knigge & Drew 1997, ApJ, 486, 445
Lucy 2002, A&A, 384, 725
Matthews et al., in preparation
Rutten, van Paradijs & Tinbergen 1992, A&A, 260, 213
Silk & Rees 1998, A&A, 331, L1

21. ADDITIONAL RELEVANT FIGURES AND GRAPHICS

Any additional figures or graphics not already inserted in the text boxes can be placed here, provided the 4 page limit is maintained.

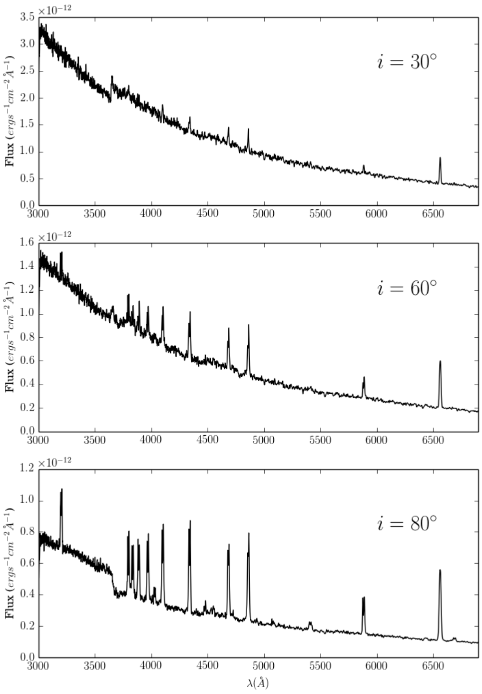


Figure 1: A simulated spectrum at angles of 30, 60 and 80 degrees, which are the viewing angles corresponding showing to the inclinations of the three targets. Recombination lines in the Balmer series and Helium I & II are prominent. The filling in of the Balmer jump can be seen clearly in the highest inclination model.