MEMORY EFFECTS AND THE LWS RSRF *

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ABSTRACT

The LWS Relative Spectral Response Function (RSRF) has been derived from an observation consisting of 36 full grating scans on Uranus in revolution 317. Two aspects of this calibration on LWS user's data are described. The first aspect is the detector memory effects in the derivation and the application of the RSRF. The second is the known problems with the Uranus model applied.

Key words: calibration.

1. LWS DATA PROCESSING

The LWS auto analysis stage of the pipeline converts the processed output from individual ramps, essentially photocurrent at mechanism position, to spectra in terms of flux and wavelength. For grating spectra, this consists basically of four steps, subtraction of dark background, removal of instrument response function, flux adjustment (correction for responsivity drifts) and conversion of grating position to wavelength. As the data processing is done in this way, the derivation of the response function becomes essentially a one stage process of dividing the data obtained on the reference source by its model. This empirical method has the advantage that it is simple and yields good repeatability and a stable flux calibration. It however has the disadvantage that it relies on one specific model of the reference source and any inaccuracies in this model are passed to all calibrated LWS spectra.

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2. AFFECT OF DETECTOR BEHAVIOUR ON URANUS RAW DATA

It has long been known that the LWS detectors exhibit short term changes in responsivity due to both the affect of glitches and due to changes of illumination (Swinyard et al 1996). The effect of changes of illumination is particularly apparent in observations of strong emission lines where users are advised to only use the falling edge of the line, i.e. decreases in flux which are tracked more accurately than increases in flux.

This problem is compounded by the fact that many of the instrument filters have a steep edge response. Therefore when deriving the instrument response for a particular object one is faced with the problem that this response is actually dependent on the scan direction. Figure 1 shows the averaged responses for detectors SW1 and LW2 resulting from averaging only forward scans (dashed line) and only backward scans (solid line).

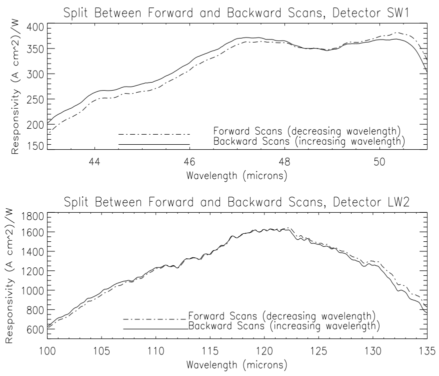

Figure 1. The RSRF for detectors SW1 and LW2.

3. THE AVERAGED RSRF APPLIED BACK TO THE REFERENCE

The currently adopted RSRF is one where scans in both directions are averaged together. When the averaged RSRF is applied to an independant observation of Uranus, there is for some detectors a clear split in the output spectra due to the scan direction used. The most affected detectors are SW1 and LW2, and two individual scans, one forward (dashed line) and one backward (solid line) are shown in Figure 2. For most detectors however this effect is small enough to be within the noise of the scan. For LW2 the effect can be corrected by co-adding the same number of scans in each direction.

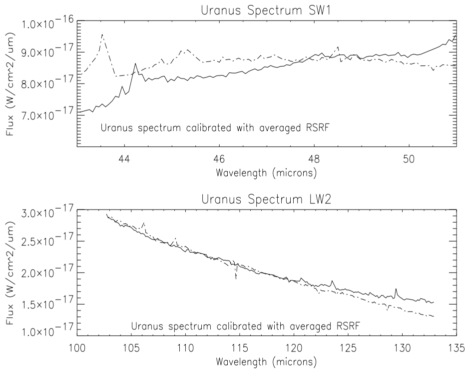

Figure 2. The RSRF for detectors SW1 and LW2.

4. FEATURES FOUND IN THE URANUS SPECTRUM

The model of Uranus used is that published by Griffin & Orton (1993), with a 0.5K temperature increase. This model works very well and continuing use of the LWS gives a steadily increasing confidence overall. The model is featureless. However, careful investigations of a few high S/N ratio spectra of different characteristics have revealed several Uranus *absorption* features, which appear as spurious *emission* lines in the output products from offline processing. The wavelengths and equivalent widths of the Uranus absorption features are tabulated in Table 1. The most notable among them are the Uranus HD R(1) 56μm and R(0) 112μm lines. The HD R(1) line has been characterized by comparing high quality data from NGC 7027 and Eta Carina. The Uranus HD R(0) absorption line has now been directly measured using the Fabry Perot, yielding an equivalent width in good agreement with that derived from NGC 7027. There are also three unknown features coincident in wavelength with the [N III] 57.3μm line.

5. CONCLUSIONS

The detectors exhibit memory effects due to scanning over the instrument response in different directions and these become a factor when applying the RSRF in the data processing. At present we do not yet have a full understanding of the memory effects as these are produced by a combination of the source energy distribution and the instrument profile. Work is ongoing in investigating a calibration for each scan direction separately but this has the disadvantage of effectively decreasing the S/N on the RSRF by root(2). It is also clear that this will still work best only when applied to falling edges. Hence the current method of using the averaged RSRF will continue to be the approach for Off Line Processing version 7.

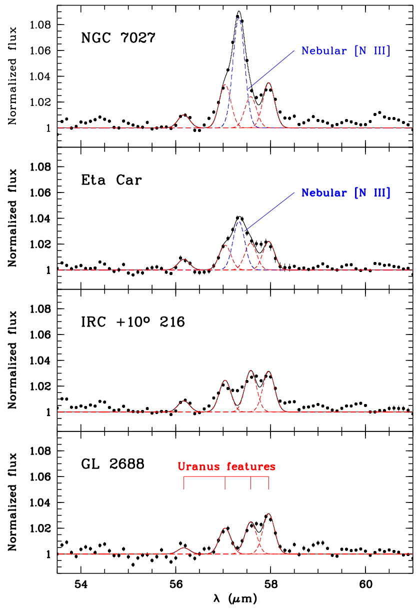

Figure 3. Spurious features in the LWS RSRF as seen in the spectra of NGC 7027, Eta Car, IRC+10^{o}216 and GL 2688.

Feature	Wavelength (μm)	EW (*$10^{-3}\mu$m)
HD R(1)	56.23	2.4±0.4
Unknown	57.04	8±1
Unknown	57.58	7.8±0.8
Unknown	57.96	9±1
HD R(0)	112.07	14±1

Table 1. Spurious features found in the LWS RSRF

Several absorption features, including the HD R(0) and R(1) lines at 112 and 56 μm, are now known to be present in the Uranus spectrum, which was predicted to be featureless at the LWS grating resolution. They produce spurious *emission* lines in the output products from offline processing and need to be corrected for sources of strong continuum.

REFERENCES

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