S/N CHARACTERISTICS OF LWP AND LWR CAMERAS AT HIGH DISPERSION *

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SUMMARY

A comparison between the signal-to-noise (S/N) ratios of the LWP and the LWR camera at high dispersion is presented. Two methods were used to obtain these ratios: a polynomial fit of the net spectra and a simplified Fourier analysis. The LWP, compared with the LWR, provides a better S/N longward of 2500 A. The opposite happens shortward of this wavelength.
The data reduction was carried out with the Tololo-Vienna Interactive Image Processing System at VILSPA.

INTRODUCTION

High resolution spectra of the three standard stars HD93521, BD + 28°4211 and BD + 75° 325 were used for the investigation of the noise characteristic of the LWP camera. The image numbers and the observational data are given in Table 1.

TABLE I: IUE Images used

Image No.	Object	Exp.time	Date	Observer
LWR 13186	BD+75°325	2160 s	07May82	Cassatella
LWP 1464	BD+75°325	1960 s	25Jan82	Wamsteker
LWR 5024	BD+28°4211	4800 s	13Jul79	Beeckmans
LWP 1441	BD+28°4211	4080 s	14Jan82	Patriarchi
LWR 9953	HD 93521	270 s	19Feb81	Bianchi
LWP 1280	HD 93521	240 s	19Feb81	Bianchi

Fourteen orders were chosen at intervals of approximately 100 A. The net spectra were resampled at constant intervals using linear

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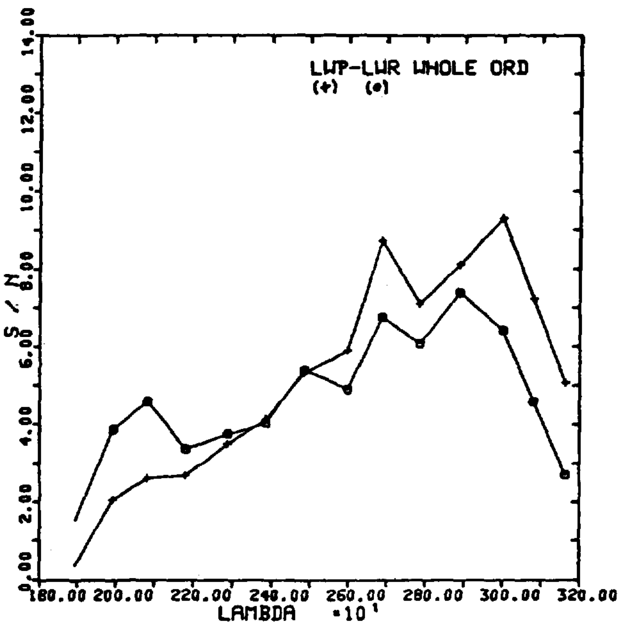


Figure 1. S/N ratio as obtained by fitting the whole order with a polynomial of second degree including negative values at the end.

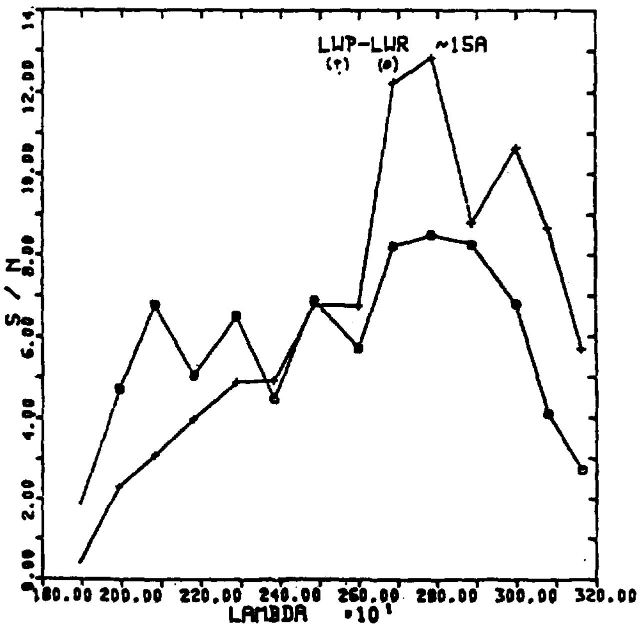
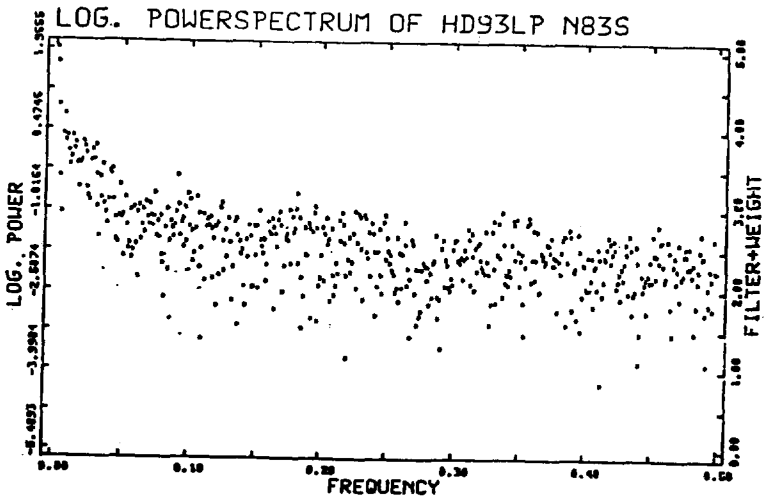


Figure 2. Same as figure 1,but here only the middle part of the individual order was fitted.

interpolation. This procedure has certainly reduced the noise contents of the spectra somewhat, but this is not significant. Two methods were applied to obtain the S/N ratio for each individual order: a polynomial fit and a simplified Fourier analysis.

POLYNOMIAL FIT

In this case the net spectrum was fitted by a polynomial of second degree. This fit was used to determine the S/N-ratio by two different methods. One using the whole order fit and the other using only the middle part of each order. This served to analyse the consequences of the inclusion of the negative values at the ends of the orders, which were excluded by the use of the truncated orders.
The mean value of each range fitted was taken as representative of the signal and the square root of the reduced chi square $\chi = [(Y-Y(fit))^2/n]^{1/2}$, where n is the degree of freedom (which is the number of data points minus the number of coefficients minus 1), was taken as that one for the noise.



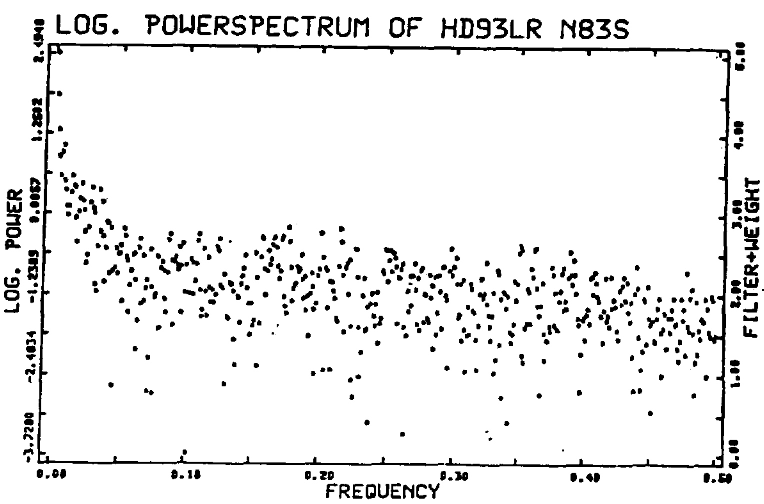


Figure 3: The logarithmic power spectra of order 83 for the LWP camera (top) and the LWR camera (bottom) versus Nyquist frequency (see text).

The results are shown in Fig. 1 (whole order fit) and Fig. 2 (fit of the middle part of an order). There the average of the S/N ratio of the three stars are presented. Although LWP has a worse noise characteristic from 1800 A to 2400 A, it behaves better than LWR longward of 2500 A (see also LWP User's Guide).

FOURIER ANALYSIS

In order to prove the results obtained by the method above, I use a Fourier analysis of the net spectra of the star HD 93521 employing the Fourier-package of the Tololo-Vienna Image Processing System. The logarithmic power spectrum of each order was plotted against the Nyquist frequency Ny (= 1/2 Δx, where Δx is the distance of the data points).
The following two assumptions were made: 1, all the signal is contained in the lower frequencies (i.e. from 0.0 to 0.25 Ny) and 2, the higher frequencies (from 0.25 to 0.25 Ny), contain the noise only. Then the area under the power spectrum from 0.0 to 0.25 Ny is representative of the signal and the area under the spectra from 0.25 Ny represents the noise.

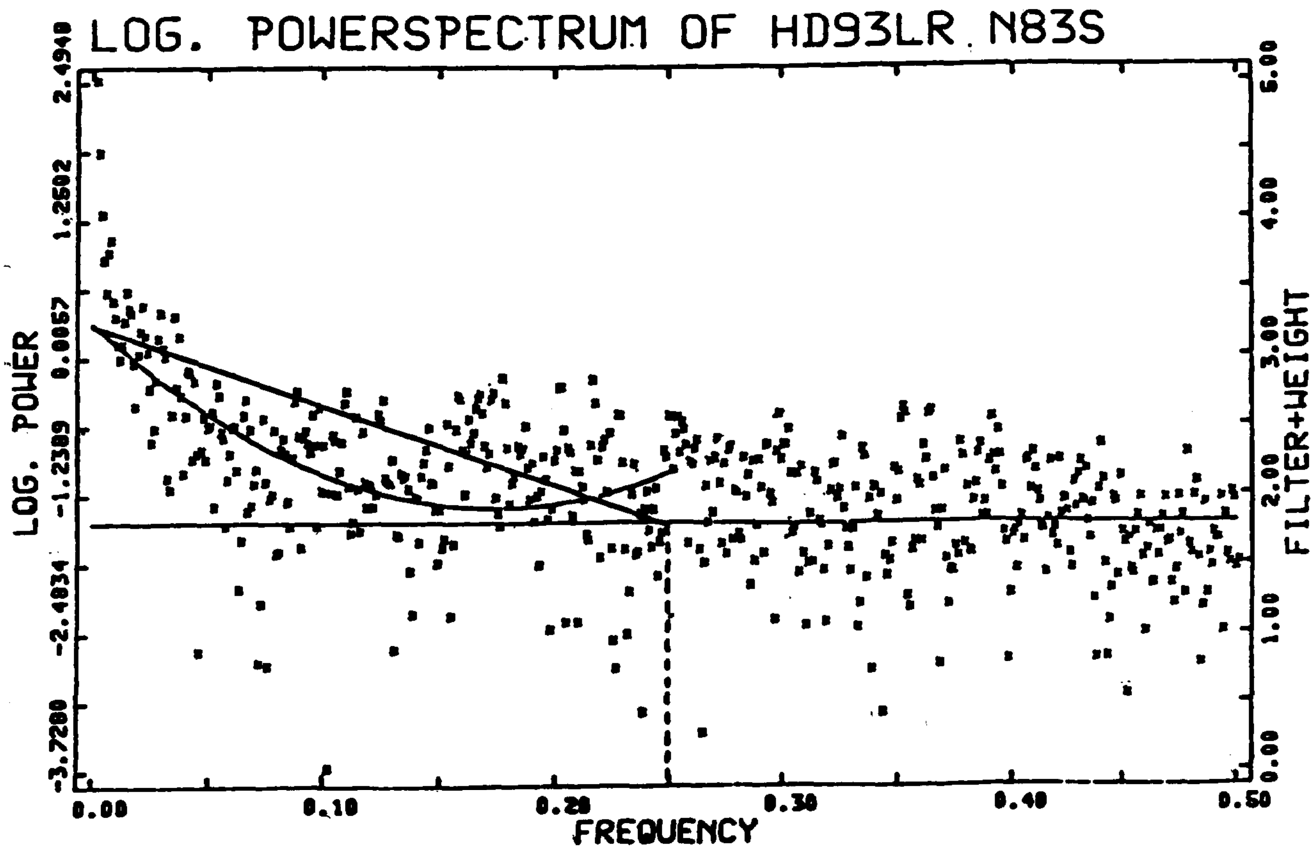


Figure 4: Illustration of the simplifications done in order to compute the areas under the power spectrum (see text).

As one can see in Fig. 3 the computation of the real area under the power spectrum is not an easy task. Therefore some simplifications were made. The power spectrum form 0.0 to 0.25 Ny was first approximated by a Voigt function, which was subsequently substituted by a straight line (see Fig. 4). The part from 0.25 to 0.5 Ny of the power spectrum was fitted by a constant (assuming "white noise"). The results (Fig. 5) of this method confirm the results obtained with the polynomial fitting approach.

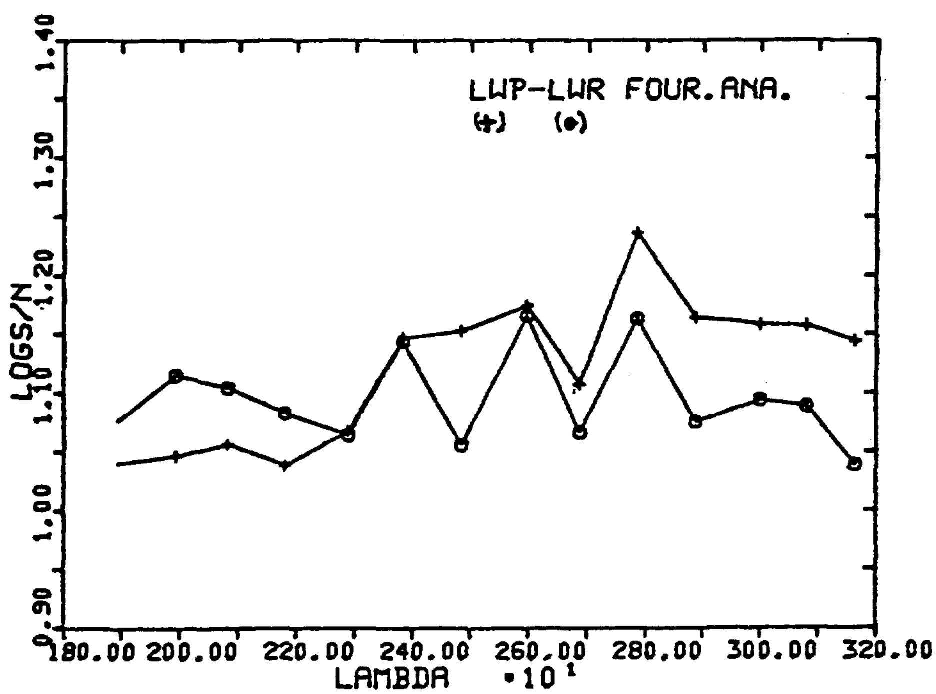


Figure 5. Result of the simplified Fourier analysis. These results are in good agreement with those obtained by the polynomial fit shown in figure 1.

S/N AT THE MgII LINES

The signal-to-noise ratios of LWP and LWR at the two resonance lines Mg II 2795.5 and Mg II 2802.7 are of special interest.
A polynomial fit, as described above, was made over an interval of 4 A centered at these two lines.
The Mg II 2802.7 lies close to the end of order 83, therefore the S/N ratios for this line were computed at the end of order 83 (+) and at the beginning of order 82 (x)

(see Fig. 6). The S/N ratios of the Mg II 2808.7 line of these two different orders are not comparable, because they represent the characteristics of a completely different area of the detector. Fig. 6 shows a comparison of the S/N ratios of LWP and LWR as obtained for the same three standard stars. As one can see for the Mg II 2795.5 line of order 83 (o) the ratios lie above the 1:1-line in favor of the LWP. The same holds for the Mg II 2802.7 line of order 82 (x), LWR seems to have an equal (in case of star BD + 75° 325 (2,) even a better) noise characteristic than LWP.

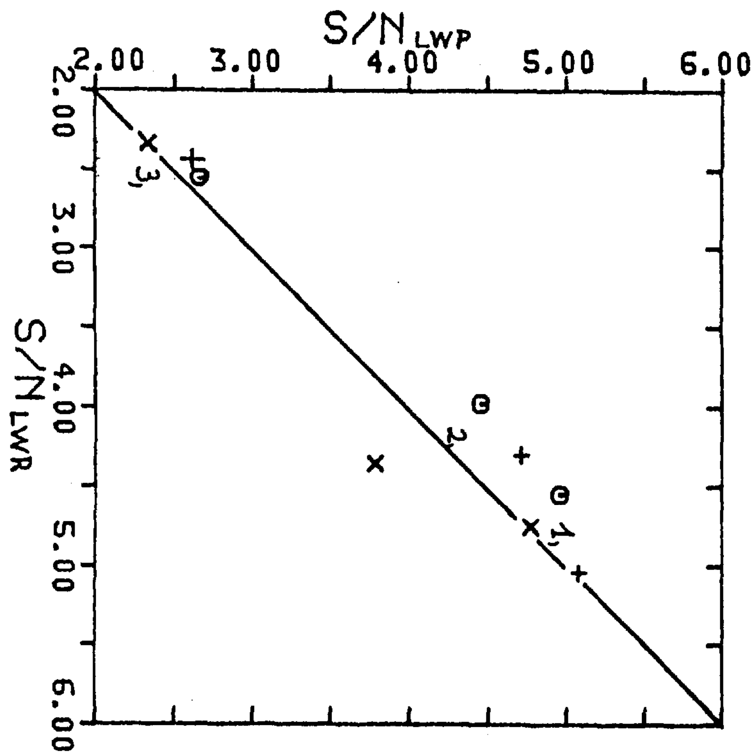


Figure 6. Comparison of the S/N ratios of the LWP and LWR cameras at the position of the Mg II lines for the stars BD +28°4211 (1), BD +75°325 (2) and HD 93521 (3). See also text.

CONCLUSION

It appears, that LWP is mainly useful for spectral studies in the wavelenght range from 2500 to 3200 A. In this region the S/N in the LWP is about a factor of 1.4 better than in LWR. Conversely the LWR seems to be more appropriate for studies shortward of 2500 A, where it is clearly better than the LWP both in terms of S/N and of sensitivity. For studies of the Mg II lines of order 83 again the usage of LWP is advisable.

ACKNOWLEDGEMENT

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