QUICK STUDY OF S/N DEGRADATION DUE TO HIGH BACKGROUND

AND

S/N IMPROVEMENT FROM USING A FLAT FIELD

IN

IUE SPECTRA OF WD1327-083=WOLF 485

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1988 August

WD1327-083 (Wolf 485) is a well observed object where a large fraction of the observations have a high radiation background, even though the exposure time is only 10-20 minutes. Because of this unusual situation, an empirical study is possible of where high background spectra begin to degrade the S/N of an average of many spectra of equal exposure time. Eye estimates of S/N are in the range 2-4 times worse for individual high-background spectra in comparison to low background spectra, where the division between high and low background is defined to be where the net flux number (FN) at the peak detected IUE signal in FN is equal to the background FN. The IUE net FN is the total gross response minus the background. All spectra are from the archive and were processed with the ITF1 for all cameras. The number of spectra included in this study is:

Camera	SWP	LWR	LWP
Number of low bkg spectra	21	0	14
Number of high bkg spectra	8	2	5

The results are that the S/N is degraded in the regions of the best signal from 34.8 to 30.2 for SWP and from 24.6 to 22.0 for the LW cameras, when the high background spectra are included in the sum.

The use of a flat field spectrum from a sum of 16 spectra of BD+28 4211 improves the S/N from 34.8 to only 36.4 for the sum of the 21 good SWP spectra.

I. HIGH BACKGROUND STUDY

FIGURE 1 shows the sum of the 21 low background (i.e. 'good') SWP spectra and the 14 good LWP spectra on a log scale.

FIGURE 2 shows the sum of the 8 high background (i.e. 'bad') SWP spectra and the 7 bad LW spectra. The LWP has such a poor S/N in the 2000-2300A region that inclusion of even 2 bad LWR spectra seem to make the co-addition superior to the good sum in Figure 1 in this restricted region.

FIGURE 3 shows the sum of all 29 SWP spectra and 21 LW spectra.

FIGURE 4 shows the residual noise in the line-free region from 1650-1925A. The plots were generated by fitting a quadratic to the data for each star and then dividing the data by the fit. The S/N drops from 34.8 to 30.2 when the 8 bad spectra are included in the sum, while the S/N for the

bad spectra alone is 16.9.

FIGURE 5 is produced in analogy with Figure 4 and shows that the S/N is reduced from 24.6 to 22.0 by including the 7 bad LW spectra.

In general, the question of how noisy a spectrum can be and still improve the net S/N in a sum can be solved in the simple case where all exposures are of the same exposure time and are co-added with the same weight. If n-1 good spectra with rms noise of r are co-added with one bad spectrum with rms noise xr, then the break even point for no change in the S/N from the n-1 sum to the sum of all n spectra is

$$x=\sqrt{n/(n-1)\ +1}$$

The value of x ranges from 1.73 for n=2 spectra to 1.53 for 4 spectra to 1.41 for a large number. Thus, the 'bad' spectra of WD1327 where x is between 2 and 4 should not be included in the sum, as shown empirically above. If the radiation background of an IUE image exceeds the net signal, that spectrum should not be used in a co-addition with 'good' low background spectra.

II. FLAT FIELD STUDY

FIGURE 6 is a residual noise plot for the good SWP spectra of WD1327 and for the sum of 16 spectra of the IUE standard stars BD+28 4211 and of BD+75 325 from Bohlin (1987, IUE Newsl. 34, 10). The dip at 1720A in BD+75 325 is a real spectral feature that artificially decreases the computed S/N.

FIGURE 7 shows the spectra of Figure 6 corrected for flat field effects by dividing by the residual noise spectrum of BD+28 4211. The S/N of BD+75 325 improved from 31.7 to 38.7, while WD1327 improved only from 34.8 to 36.4. The flat field may not be appropriate for WD1327, because the typical exposure of around 90 DN peak is lower than for the level of the standard stars.

If a different flat field is required for each net signal level and for each background level, the technique of dividing by a flat field to reduce the fixed pattern noise is difficult to apply in the general case.

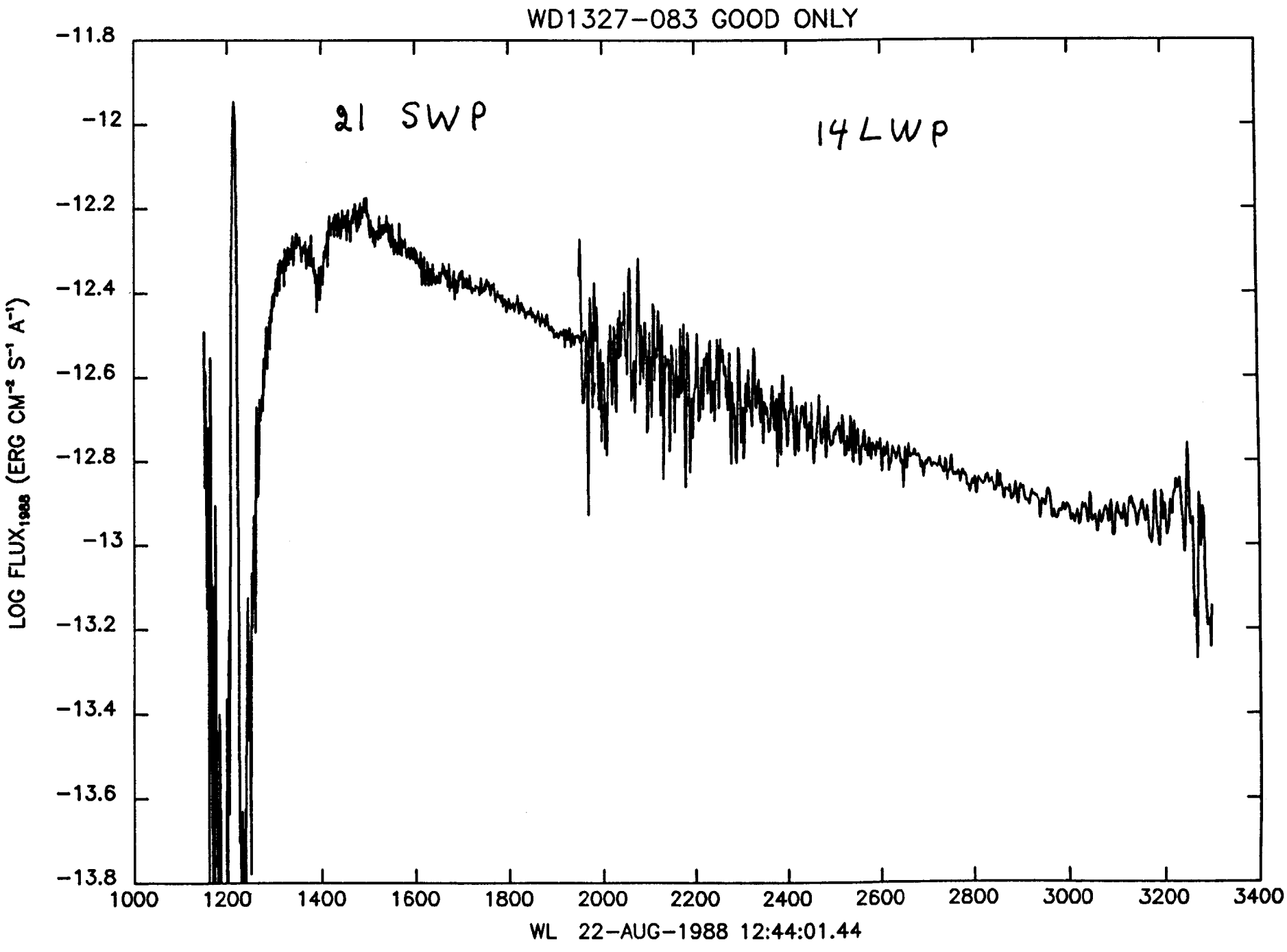
WD1327-083 GOOD ONLY
21 SWP
14 LWP
LOG FLUX1988 (ERG CM-2 S-1 A-1)
-11.8
-12
-12.2
-12.4
-12.6
-12.8
-13
-13.2
-13.4
-13.6
-13.8
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
WL 22-AUG-1988 12:44:01.44

Fig. 1

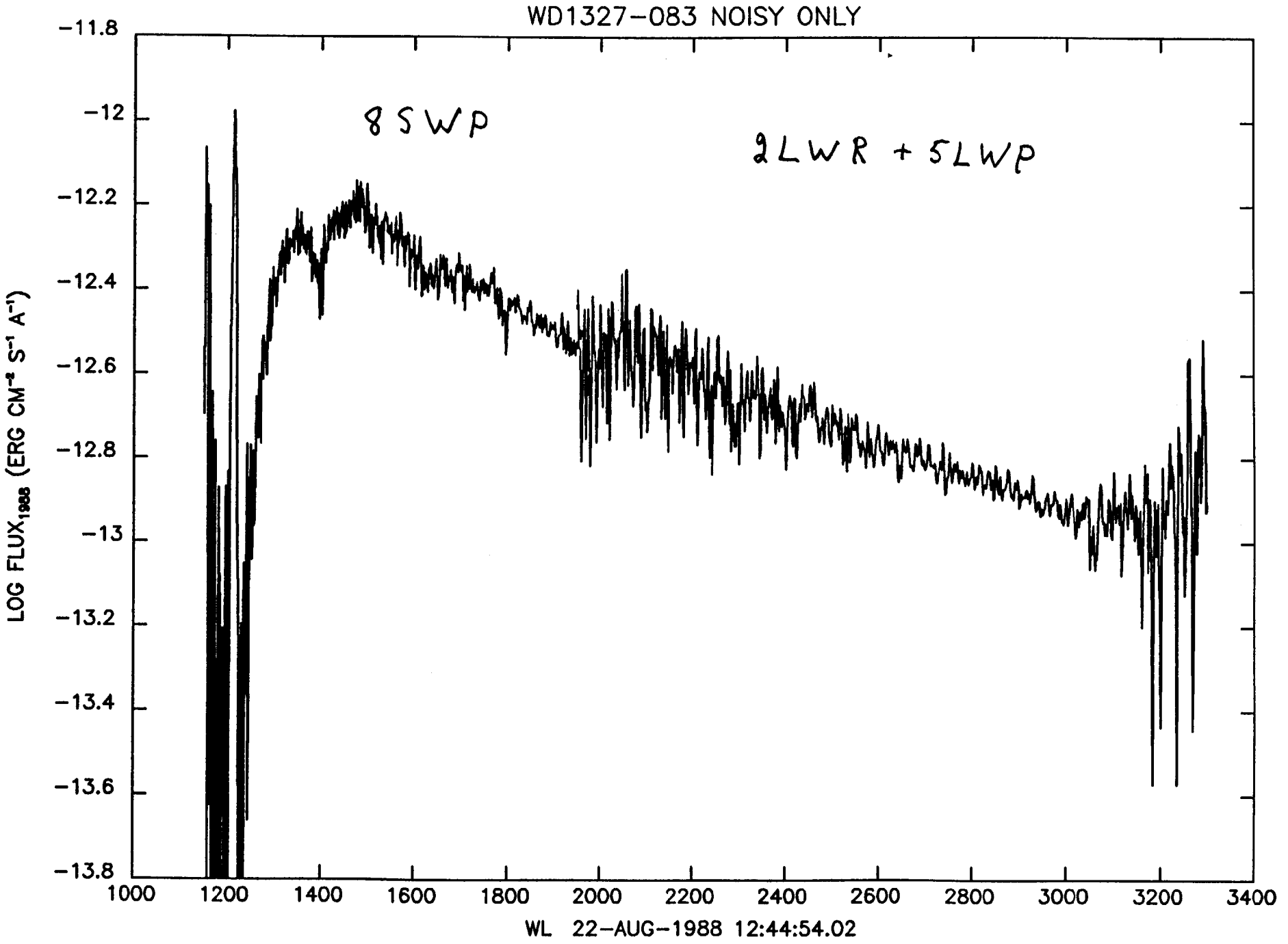
WD1327−083 NOISY ONLY
8 SWP
2 LWR + 5 LWP
LOG FLUX1988 (ERG CM−2 S−1 A−1)
−11.8
−12
−12.2
−12.4
−12.6
−12.8
−13
−13.2
−13.4
−13.6
−13.8
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
WL 22−AUG−1988 12:44:54.02

Fig. 2

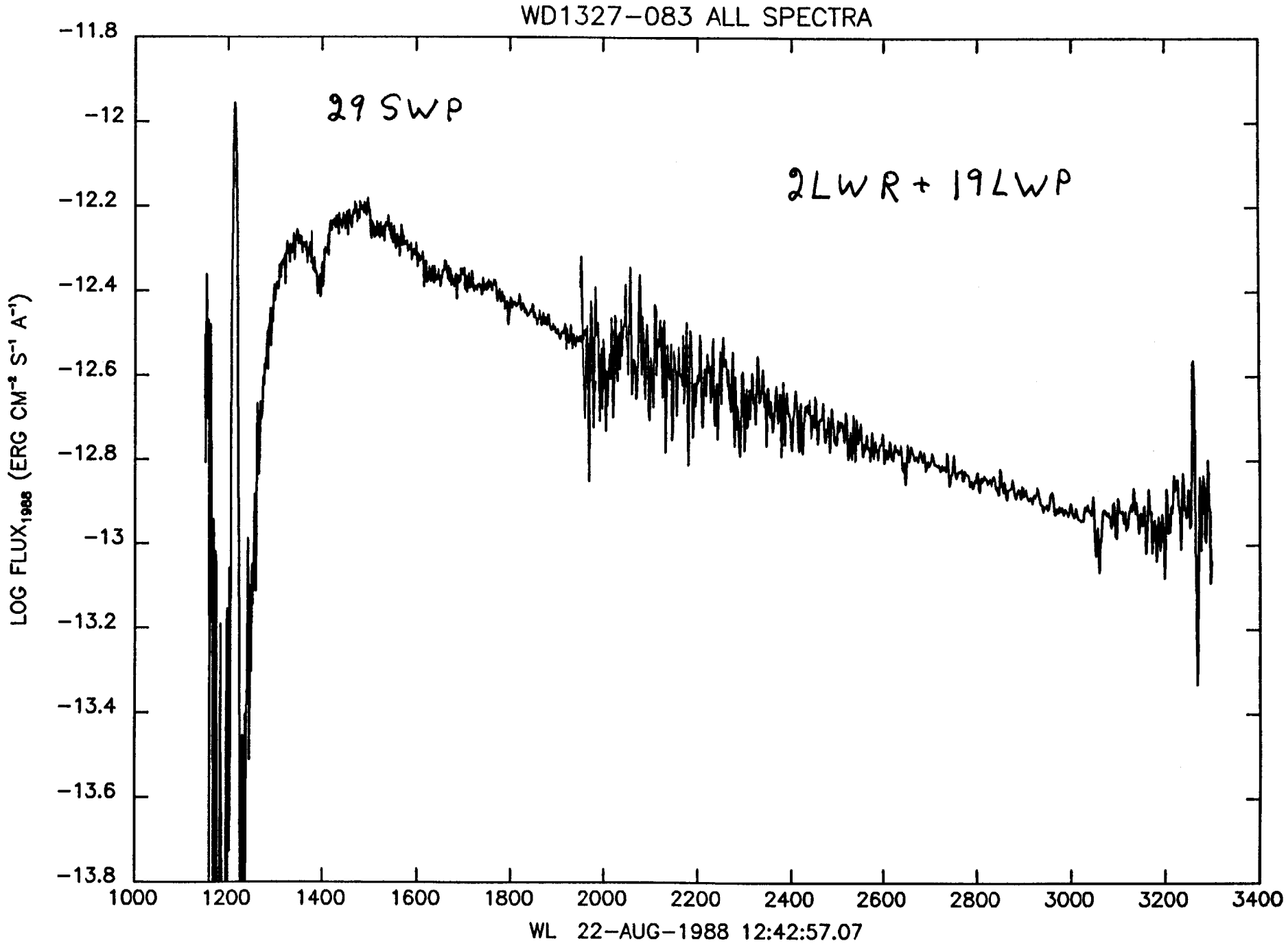
WD1327−083 ALL SPECTRA
29 SWP
2LWR + 19LWP
LOG FLUX1988 (ERG CM−2 S−1 A−1)
−11.8
−12
−12.2
−12.4
−12.6
−12.8
−13
−13.2
−13.4
−13.6
−13.8
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
WL 22−AUG−1988 12:42:57.07

Fig. 3

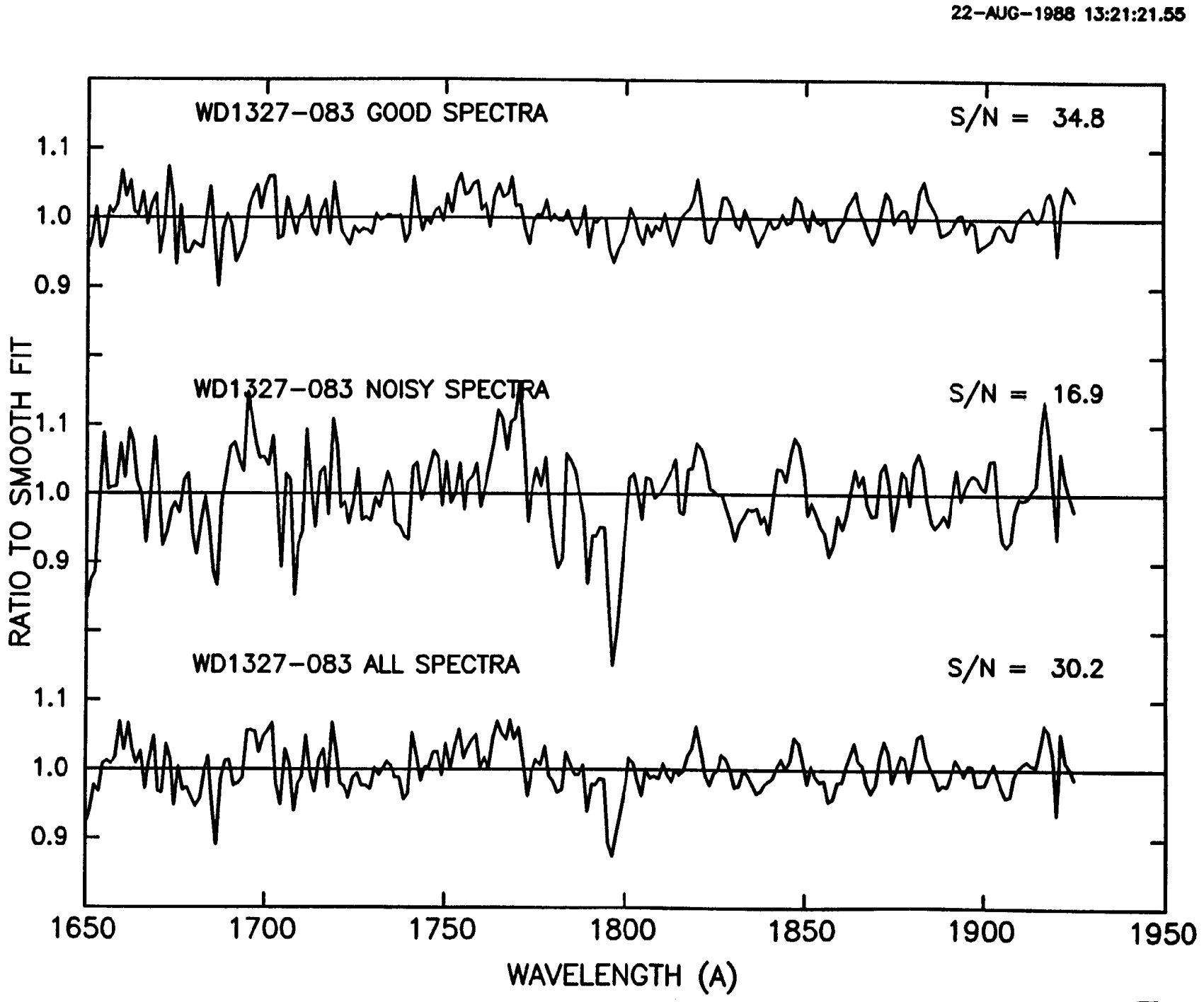
22-AUG-1988 13:21:21.55
WD1327-083 GOOD SPECTRA
S/N = 34.8
WD1327-083 NOISY SPECTRA
S/N = 16.9
WD1327-083 ALL SPECTRA
S/N = 30.2
RATIO TO SMOOTH FIT
1.1
1.0
0.9
1650
1700
1750
1800
1850
1900
1950
WAVELENGTH (A)

Fig. 4

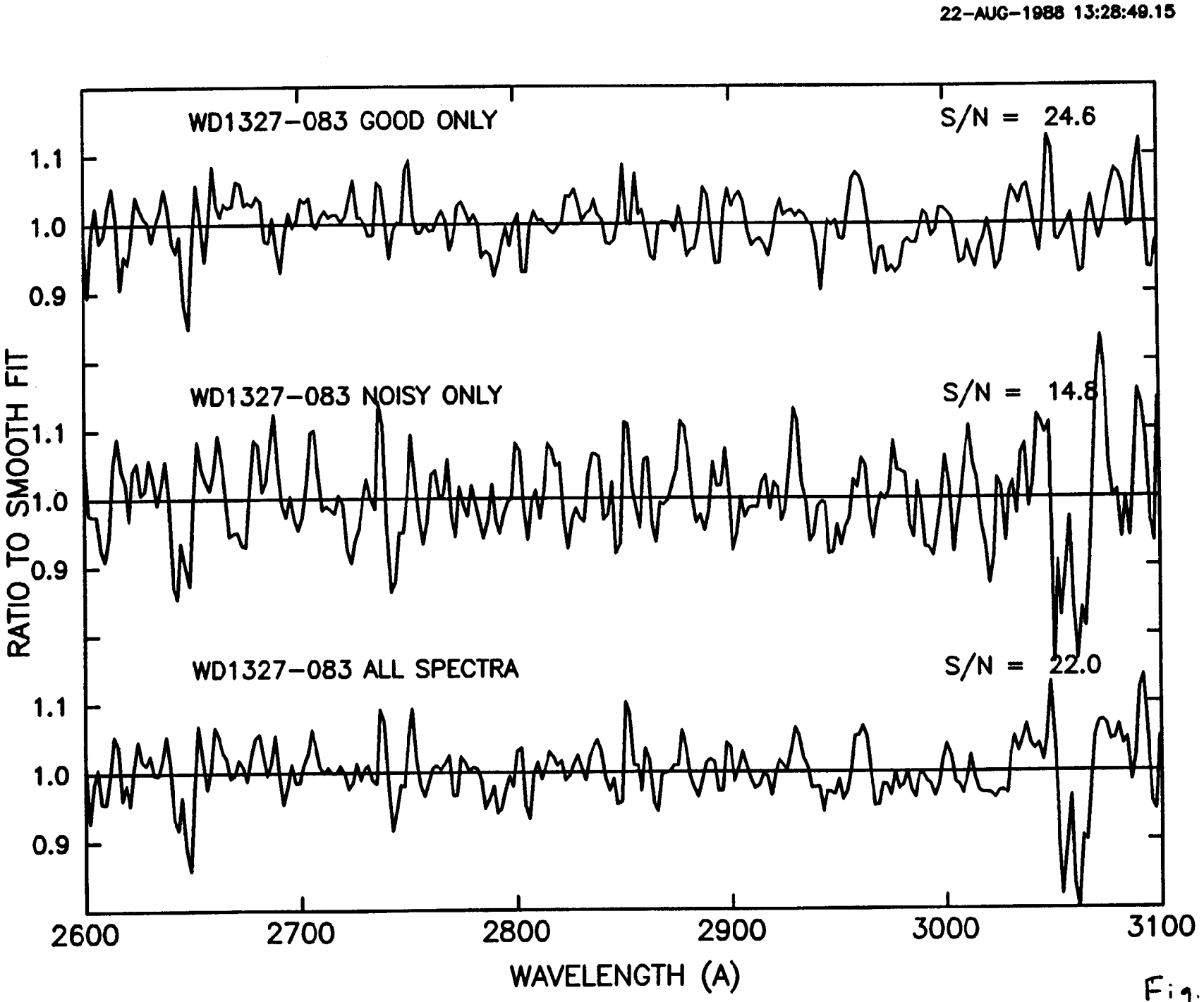
22-AUG-1988 13:28:49.15
WD1327-083 GOOD ONLY
S/N = 24.6
WD1327-083 NOISY ONLY
S/N = 14.8
WD1327-083 ALL SPECTRA
S/N = 22.0
RATIO TO SMOOTH FIT
1.1
1.0
0.9
2600
2700
2800
2900
3000
3100
WAVELENGTH (A)

Fig. 5

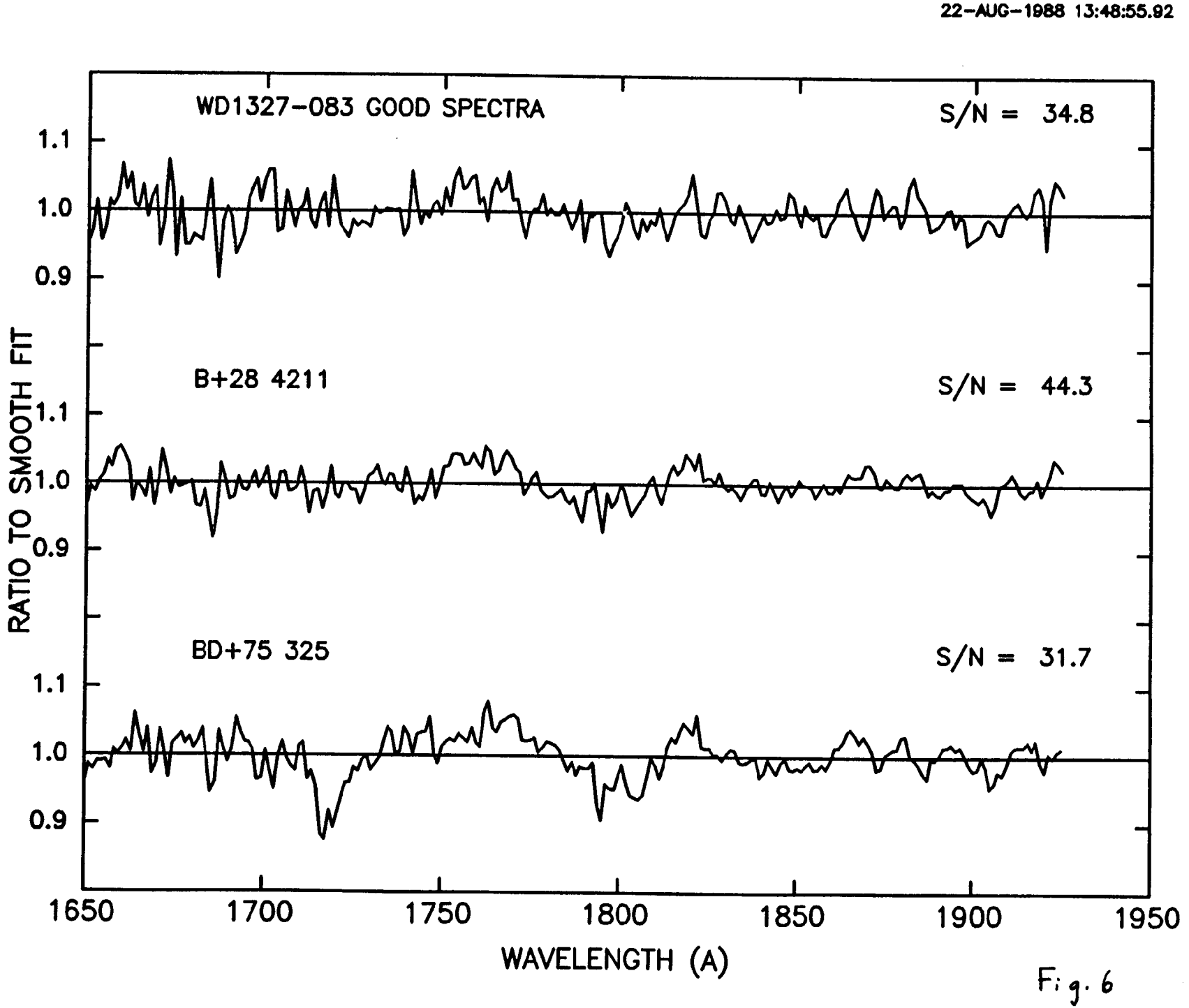
22-AUG-1988 13:48:55.92
WD1327-083 GOOD SPECTRA
S/N = 34.8
B+28 4211
S/N = 44.3
BD+75 325
S/N = 31.7
RATIO TO SMOOTH FIT
1.1
1.0
0.9
1650
1700
1750
1800
1850
1900
1950
WAVELENGTH (A)

Fig. 6

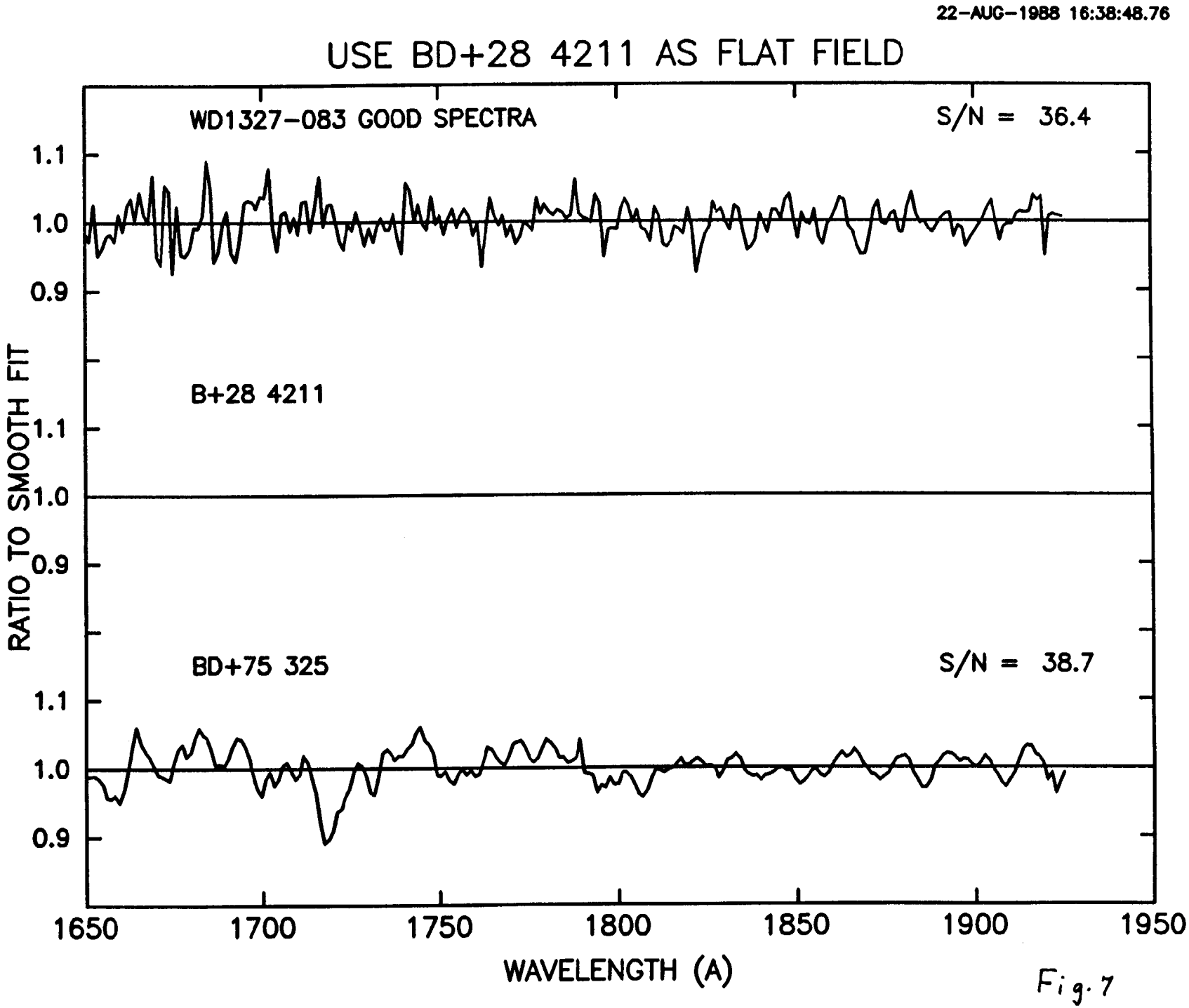
22-AUG-1988 16:38:48.76
USE BD+28 4211 AS FLAT FIELD
WD1327-083 GOOD SPECTRA
S/N = 36.4
B+28 4211
BD+75 325
S/N = 38.7
RATIO TO SMOOTH FIT
1.1
1.0
0.9
1650
1700
1750
1800
1850
1900
1950
WAVELENGTH (A)

Fig. 7