Absolute calibration of the LWP with ITF2

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1. Introduction

In this paper we present the new absolute calibration based on ITF2. We have already shown (Cassatella and Lloyd 1987) that ITF2 has superior linearity and signal-to-noise to ITF1 and have also presented a preliminary absolute calibration based on the new ITF (Cassatella et al. 1987). The calibration presented here includes a further OAO standard, lamda Lep, and almost twice as many spectra for zeta Cas as in the preliminary calibration. We have also added four more spectra of the TD1 standard BD+28 4211.

2. Observations

This calibration is based on three OAO standards, zeta Cas, lamda Lep and 10 Lac, and on three TD1 standards, HD 60753, BD+28 4211 and BD+75 325. The image numbers are given in Tables 1 and 2. The OAO standard mu Col has not been used as there are now doubts about its constancy. The spectra used have been limited to the years 1983 to 1986, with most falling into the middle two years. This restriction has reduced the number of spectra used, but it is forced by the changes in the sensitivity of the LWP of the past few years (Sonneborn and Garhart 1987). The mean ephoc of the calibration is 1984.9, i.e. close to the date the LWP ITF2 were taken.

The exposure times of the ITF2 net extracted spectra were normalized to the effective exposure time calculated taking into account the OBC step (0.4096s), the dependence on THDA (Sonneborn 1984) and the camera rise time (0.12s; Imhoff 1983). The data have been corrected for the THDA sensitivity dependence given by Sonneborn (1984).

Input fluxes for the calibration standards were taken from Bohlin (1984).

The present calibration is based only on point, large aperture spectra. This applies also to the OAO standards, which have been observed with exposure times of one to two OBC steps. The use of such short exposure times brings a source of inaccuracy in the effective exposure times introduced by the command decoder cycle time. However, such effects should cancel out when disposing of a statistically significant sample of observations.
Trailed spectra were not used, because the ratio of point to trailed spectra has been shown to be wavelength dependent also with LWP ITF2 (Cassatella and Loyd 1987).

To improve the signal-to-noise ratio at the short wavelength end of the camera, a number of spectra were taken which were well exposed in the region 2000- 2200 A. The mean flux numbers were obtained, for each standard, by averaging together data in the well exposed spectral regions only.

3. Results

The inverse sensitivity of the LWP with ITF2 was first obtained separately for each of the six standards used. One important result is that the mean curve corresponding to the TD1 standards agrees well with the mean curve for the OAO standards, the one sigma errors of S_λ (TD1-OAO)/OAO in the bands 1900-2000A, 2000-2200A, 2600-2800A, and 2800-3100A being 4.3%, 2.8%, 3.5%, and 3.0%, respectively. The inverse sensitivity curve was then obtained as the weighted average of the TD1 and OAO sensitivity curve in the common region 1850-2725 A, and as the mean OAO curve in the region 2750-3350 A. Weights were given according to the number of observations available for each standard. The value S_λ^{-1}(3350 A) is based on 10 Lac, the only OAO standard with known fluxes at this wavelength. The resulting inverse sensitivity curve was then slightly smoothed in the wavelength range 1975 to 3100 A by making use of a three point gaussian smoothing. The smoothed curve agrees with the original data by less than 1%, on average. Outside the range 1975-3100 A, the original data were taken because the smoothing technique was modifying the original data by more than 1%.

The final LWP-ITF2 inverse sensitivity curve is given in Table 3 and plotted in Fig. 1. The errors we attach to this sensitivity curve are the mean repeatability errors in FN/t for the different standards. Such errors are typically around 2-3% in the region 2000 to 3300 A (2.23 % +/- .66% in the case of BD+ 28 4211). The repeatability errors are slightly larger (4% to 5%) for the OAO standards, probably because of the uncertainties on the exposure times introduced by the command decoder cycle time.

4. Comparisons

To verify the present calibration we have performed the following comparisons:

a) comparison with TD1 and OAO input fluxes (check of internal consistency). Fig. 2, 3 and 4 show a comparison between our mean flux-calibrated spectra of lambda Lep, 10 Lac and BD+28 4211 and the TD1 or OAO input fluxes from Bohlin (1984). The mean error (F_λ(stan) - F_λ(IUE))/ F_λ(stan) is + 0.022 +/- 0.06 for BD+28 4211 in the range 2200-2725 A, and -0.022 +/- 0.025 and +0.016 +/-0.026 for the OAO standards lambda Lep and 10 Lac in the range 2200-3000A, respectively. In the range 1850-2200 A the mean errors are: 0.082 +/- 0.079 for 10 Lac and 0.017 +/- 0.060 for lambda Lep.

b) comparison with LWR data. In Fig 5 we plot the ratio of fluxes from LWR17001 (corrected for the camera sensitivity lost according to Clavel et al. 1987) and from LWP4593 of BD +28 4211. The figure shows that the present calibration provides lower fluxes than LWR, by 3-4% on average.

c) comparison with IUE mean fluxes (see Bohlin 1986). The comparison is given in Fig. 6 and 7, showing the flux ratio $(F_\lambda(LWP)-F_\lambda(Bohlin))/F_\lambda(Bohlin)$ for BD+28 4211 and HD60753. The figures indicate that Bohlin's IUE mean fluxes are slightly larger compared to those obtained through the present calibration.

References

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Table 1
LWP images of OAO standards

zeta Cas	lamba Lep	10 Lac
100%		
2931	5019	5040
4866	5021	5043
5041	6637	5045
6503		6204
6505		
6507		
6570		
7210		
200%		
5042	5020	5044
6504	6639	6205
7070	6948	6206
7211	6949	6207

Table 2
LWP images of TD1 standards

HD 60753	BD+28 4211	BD+75 325
100%		
2344	2012	1863
2701	3182	3537
2714	3289	3916
2716	3307	5218
2717	3970	5219
2838	4037	5293
3415	4593	5423
3689	6039	5860
3938		6045
4122		6046
4558		
200%		
5887	2495	2455
5889	2504	5861
	3308	

Table 3: LWP inverse sensitivity curve (ITF2)

Lambda (A)	$S^{-1} x 10^{14}$
1850	18.0
1875	10.54
1900	6.88
1925	4.88
1950	3.314
1975	2.642
2000	2.392
2025	2.220
2050	2.092
2075	2.040
2100	1.988
2125	1.945
2150	1.934
2175	1.943
2200	1.945
2225	1.880
2250	1.757
2275	1.603
2300	1.473
2325	1.327
2350	1.191
2375	1.061
2400	.962
2425	.875
2450	.811
2475	.754
2500	.704
2525	.646
2550	.595
2575	.559
2600	.537
2625	.513
2650	.488
2675	.470
2700	.464
2725	.458
2750	.454
2775	.455
2800	.461
2825	.472
2850	.482
2875	.496
2900	.516
2925	.546
2950	.585
2975	.641
3000	.713
3025	.814
3050	.941
3075	1.113
3100	1.328
3125	1.612
3150	1.979
3175	2.457
3200	3.117
3225	4.001
3250	5.264
3275	6.881
3300	9.017
3325	12.34
3350	18.0

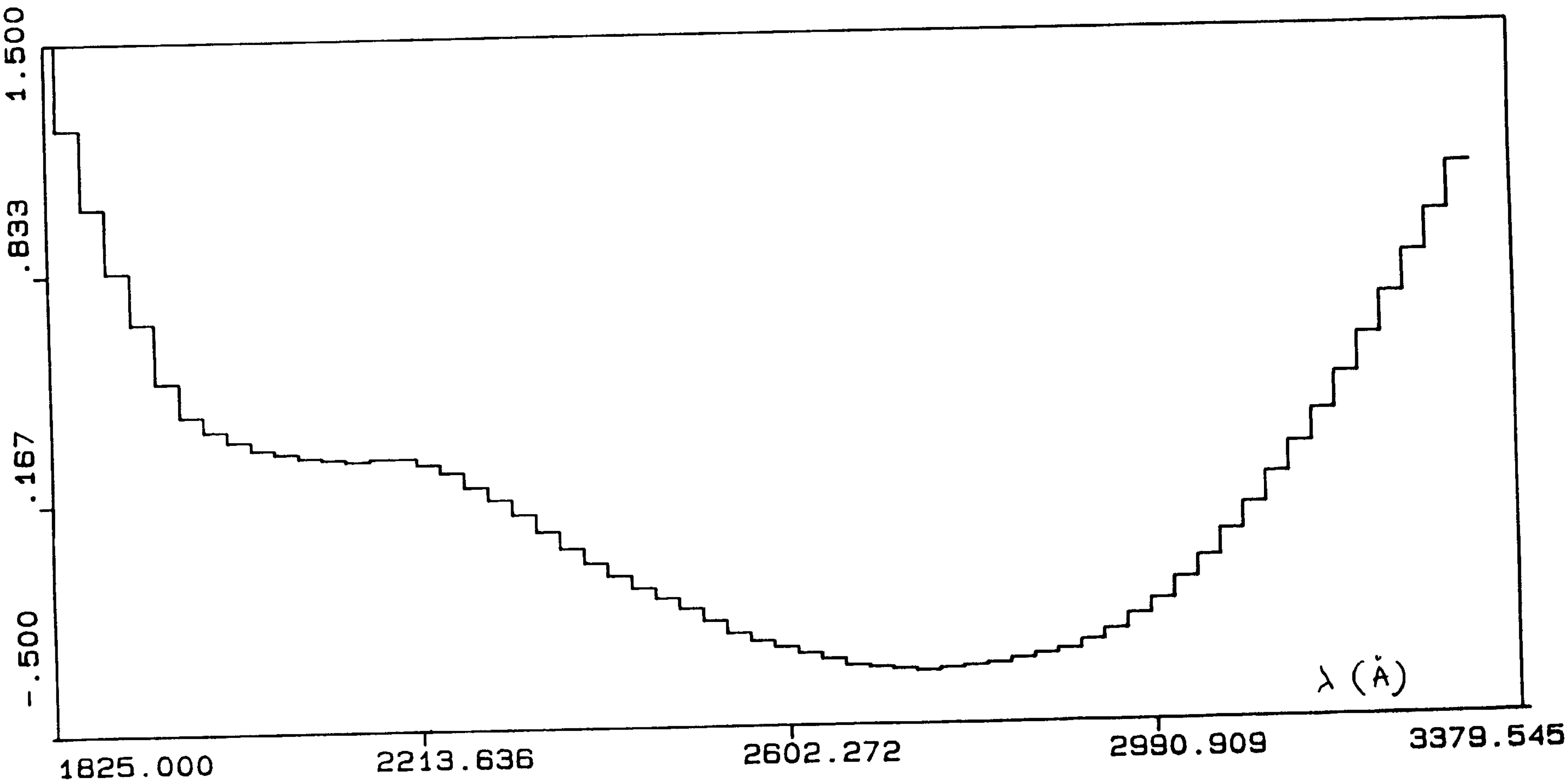

Fig. 1: Log S_{λ}^{-1} for the LWP camera (ITF2)

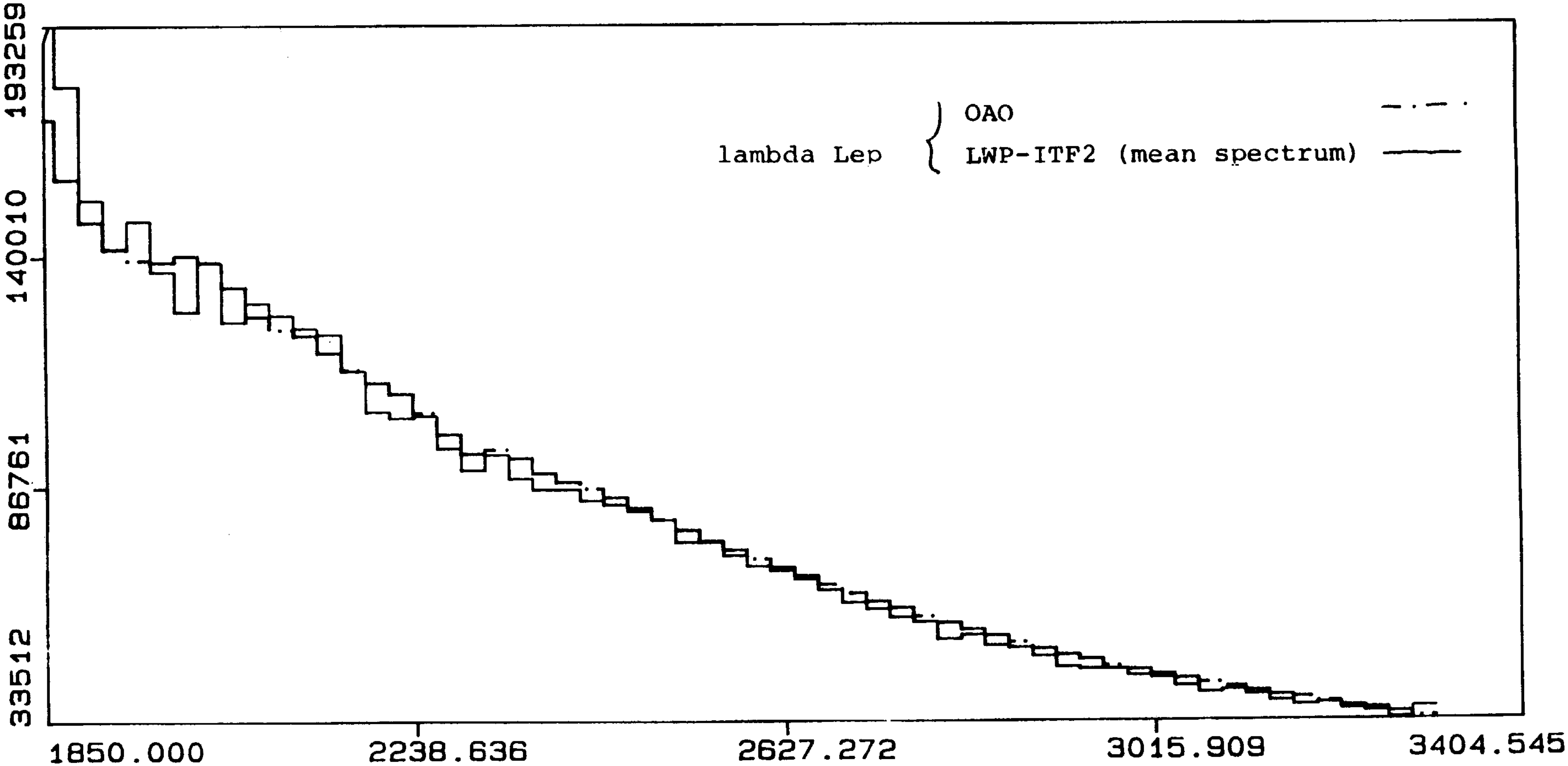

Fig. 2: Energy distribution of lambda Lep.

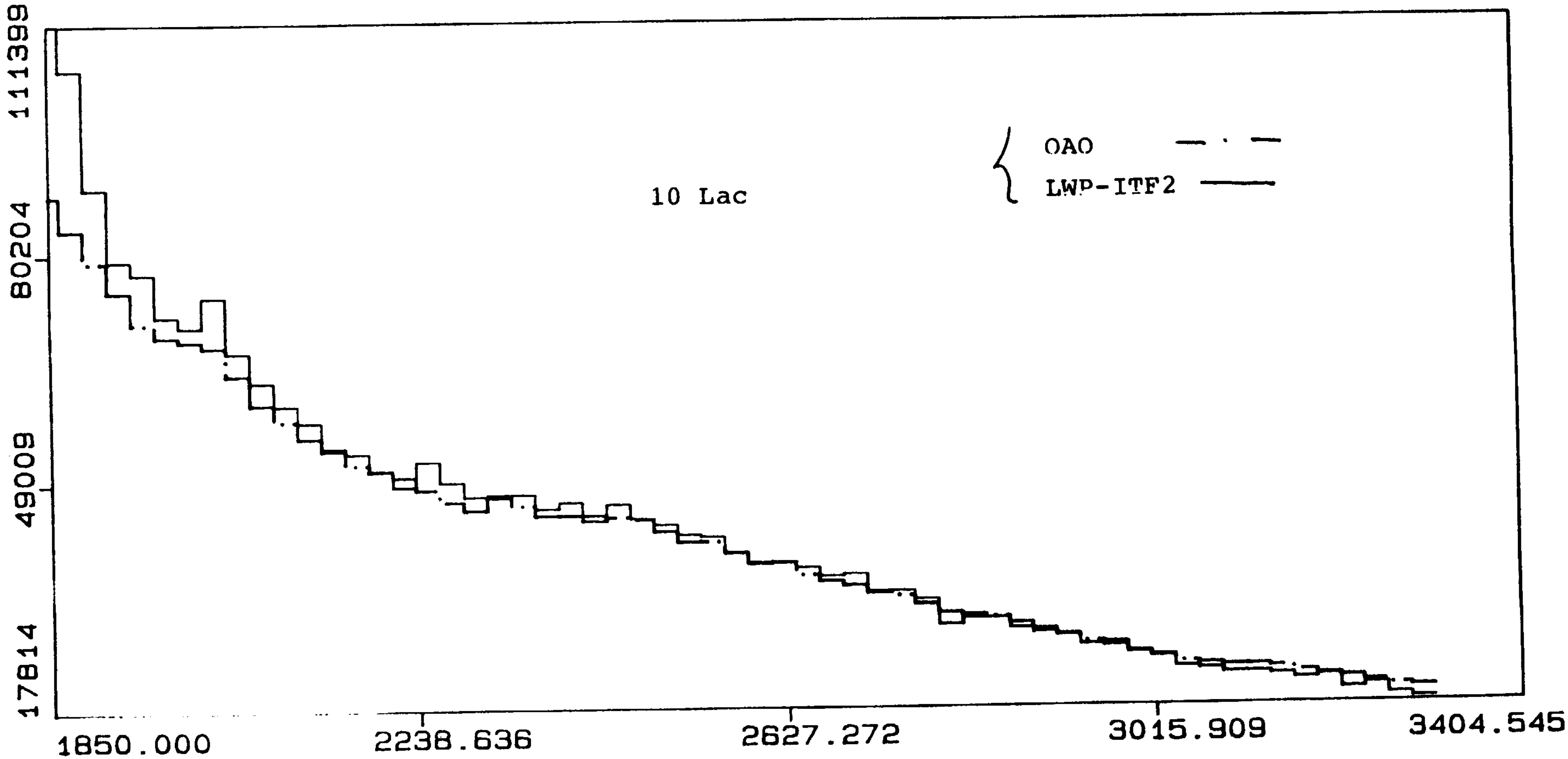

Fig. 3: Energy distribution of 10 Lac

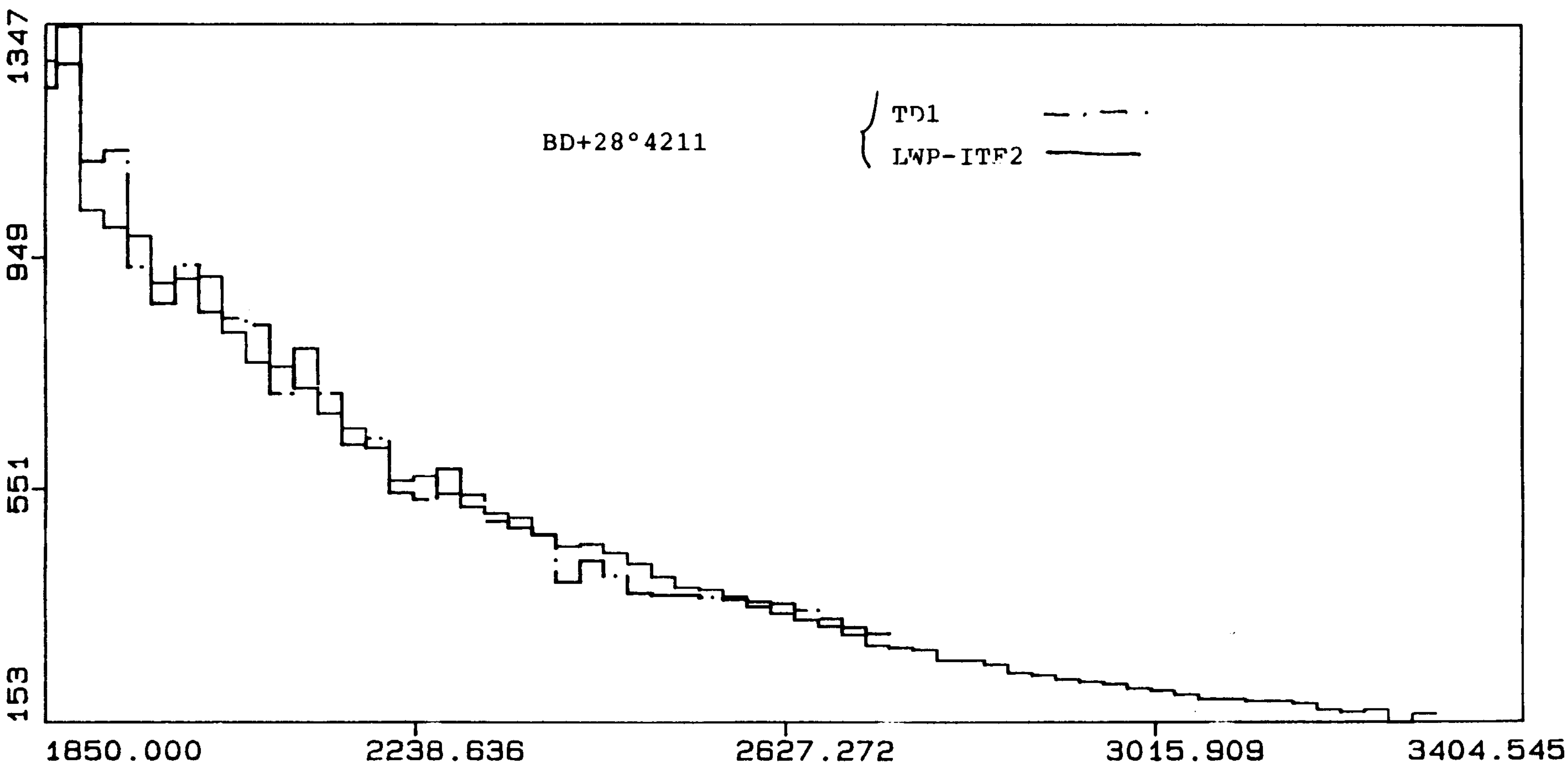

Fig. 4: Energy distribution of BD+28 4211

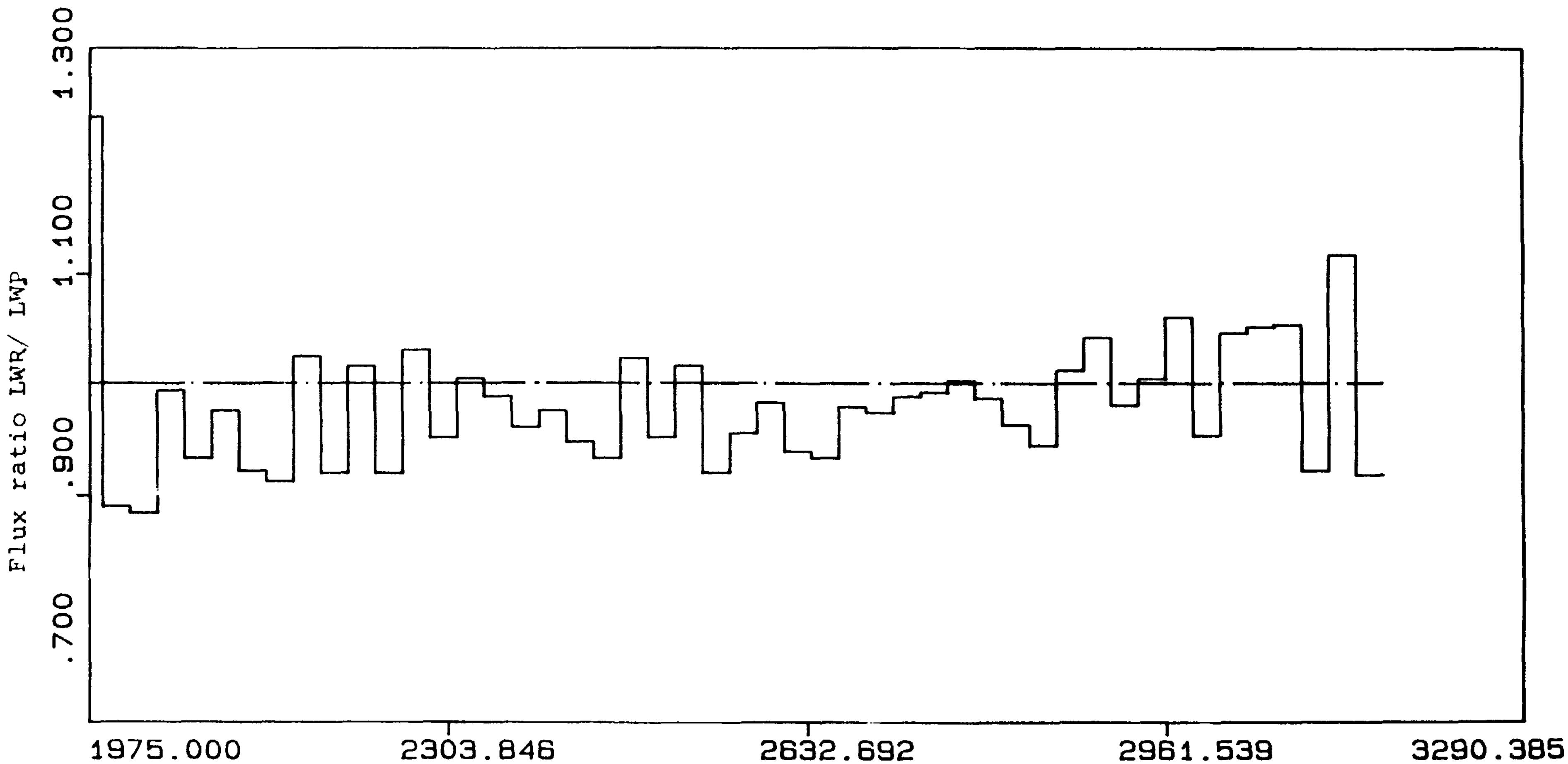

Fig. 5: Flux ratio from images LWR17001 and LWP4593 of BD+28 4211

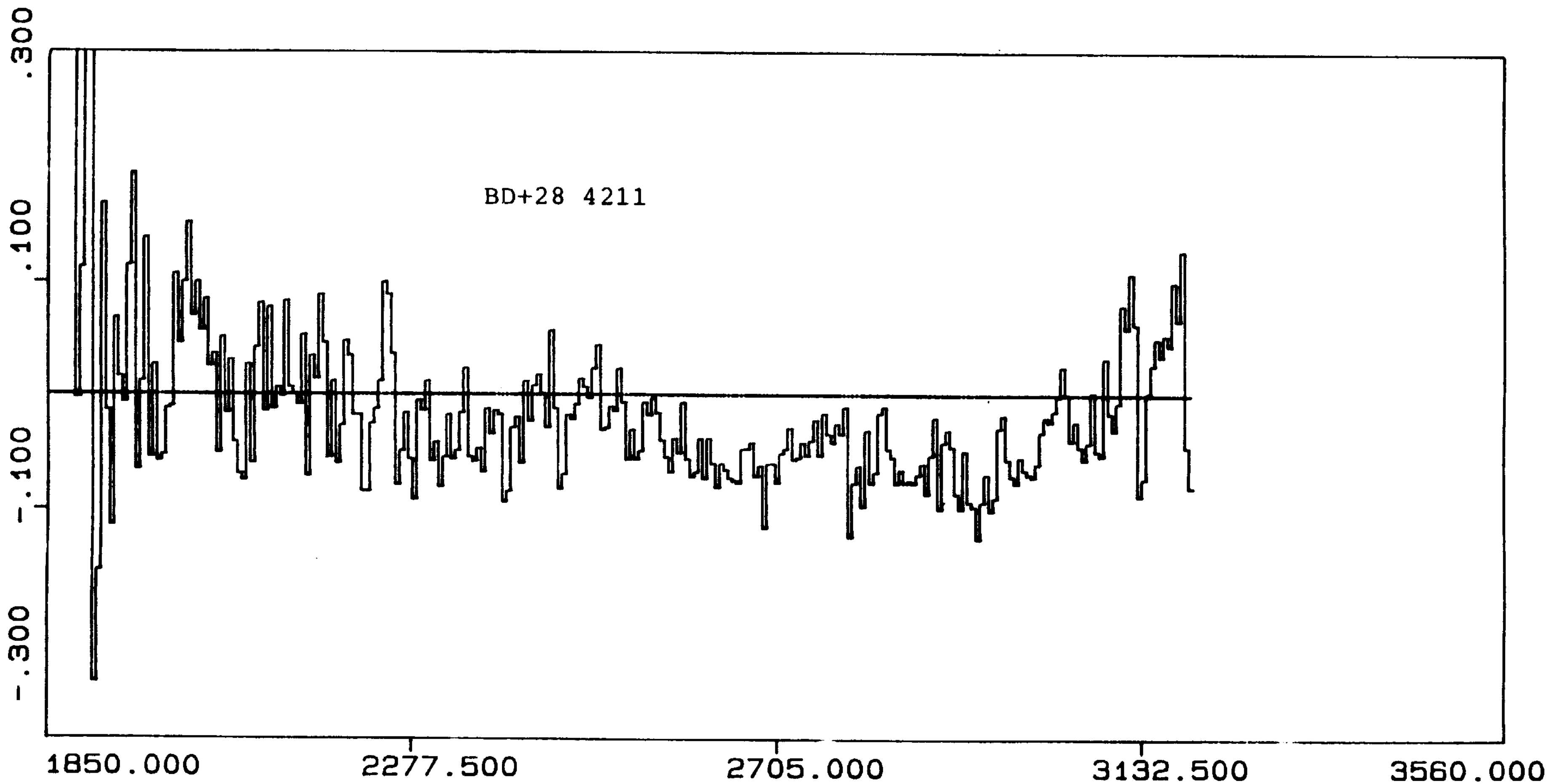

Fig. 6: Flux ratio of the mean LWP spectrum of BD+28 4211 to the mean IUE fluxes from Bohlin (1986)

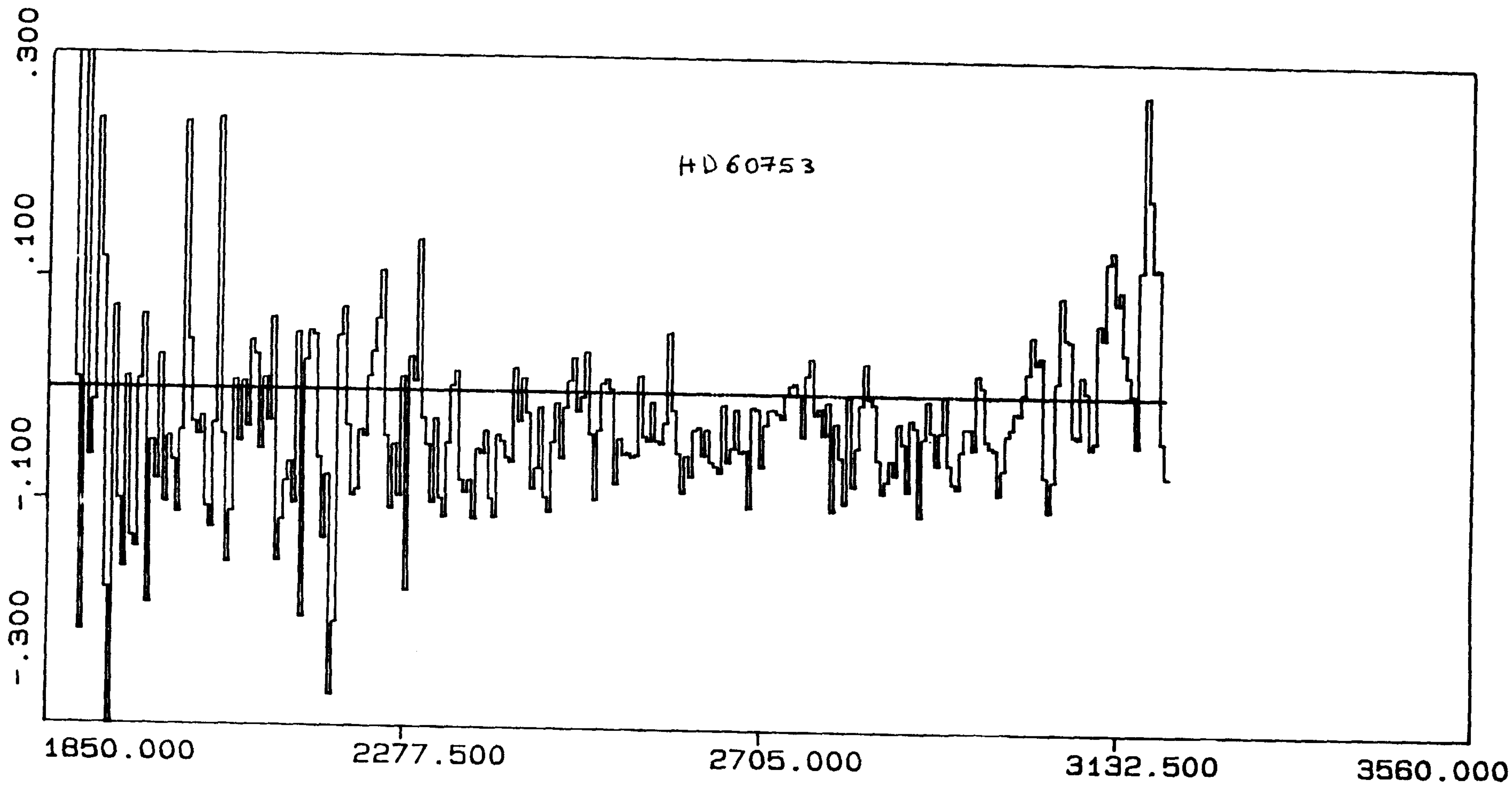

Fig. 7: same as Fig. 6 for HD60753