Comparison of the Old and New LWP Absolute Calibrations

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Introduction

The new LWP ITF (ITF2) and new low-dispersion absolute calibration were implemented in IUESIPs production processing on December 22, 1987 at both GSFC and VILSPA. The new LWP absolute calibration was derived by Cassatella, Lloyd, and Gonzalez Riestra (1987), and is presented elsewhere in this newsletter. The new LWP calibrations contain several improvements over the old calibrations. First, ITF2 is significantly less noisy than ITF1 (Cassatella and Lloyd, 1987; Nichols-Bohlin and Scott, 1986). The improved signal-to-noise characteristics are primarily due to the use of a greater number of images (4 or more) per level of the ITF2 than was used for ITF1 and due to an improved geometric correction method (TCCAL) using found reseaux positions. Second, the linearity of images processed with ITF2 are slightly improved compared to images processed with ITF1 (Cassatella and Lloyd, 1987 ; Oliversen, 1986). Finally, the absolute fluxes derived from the new LWP low-dispersion absolute calibration are more accurate than the fluxes derived from the old LWP calibration.

Various tests of the new LWP absolute calibration were performed to verify its accuracy before implementation in production processing. This paper presents the results of these tests and an algorithm for conversion of large-aperture point-source spectra, processed with the ITF1 and old absolute calibration, to the ITF2 and new absolute calibration flux scale. This algorithm will not correct for any linearity errors in ITF1 (which are not large) but will improve the absolute calibration fluxes.

Data Analysis

Five standard stars (Lambda Lep, 10 Lac, HD 60753, BD +75 325, and BD +28 4211) were chosen for comparison. Low-dispersion point-source LWP spectra of these stars were processed twice, once with the ITF2 and new absolute calibration and once with ITF1 and old absolute calibration. Both the optimally exposed (100%) and twice-overexposed (200%) spectra, listed in Tables 1 and 2 of Cassatella, Lloyd, and Gonzalez Riestra (1987), were used for this study.

All spectra processed with the old calibrations were analyzed using the following steps. First, the effective exposure times for each spectra were computed by correcting for the OBC 'tic' digitization time (0.4096 sec) and for the camera response time of 0.12 sec (Crenshaw, 1986). Second, the flux scales were corrected for the camera temperature-induced sensitivity changes assuming a temperature dependance of -0.25%/ C (Imhoff, 1986; Sonneborn, 1984). Third, data affected by reseau marks near 2850 A and 3055 A were patched over. Fourth, each of the spectra were interpolated to a common wavelength scale. Next, for each of the five stars, the 100% spectra were coadded together to form an average optimum spectrum. Similarily, the 200% spectra were averaged together to form an average twice-overexposed spectra. Finally, a "merged" spectrum was formed for each star by averaging the 200% data with the 100% data in the wavelength region where the 200% data was not affected by saturated or extrapolated data. The averages were formed by weighting by the number of spectra used and by the exposure times. In the wavelength regions where the 200% data contained extrapolated or saturated data, only the 100% data was used to form the final merged spectra.

The same spectra, processed with the new calibrations, were analyzed in a similar manner and were kindly supplied by A. Cassatella.

Results

The "old" and "new" calibration versions of the averaged spectra of each of the five standard stars are shown in Figures 1-5. For display purposes, the spectra were averaged into 25 A bins. The input calibration fluxes from Bohlin and Holm (1984) are also displayed on these figures. Note that no input fluxes are given for HD 60753, BD +75 325, and BD +28 4211 beyond 2550A because the TD1 instrument was not sensitive beyond this point. The most obvious result is that the new calibration yields fluxes which are significantly lower than the old calibration fluxes. This confirms the long standing suspicion that the old LWP calibration fluxes were too high. It can also be seen that the new fluxes are more in agreement with the assumed "true" fluxes of Bohlin and Holm (1984). One notable exception to this is BD +75 325, in which the new LWP calibration fluxes differ significantly from the Bohlin and Holm (1984) fluxes in several wavelength bins. A similar result was found by Oliversen and Garhart (1987) implying that the differences are probably due to errors in the input calibration fluxes.

For each of the five standard stars, the new and old calibration fluxes were each averaged into 10 A bin sizes and the binned new calibration fluxes were divided by the old calibration fluxes. The five ratios were then averaged together to form a mean new-to-old calibration ratio (see Figure 6). In general, the new calibration yields fluxes which are lower than the old calibration by about 4 to 7%. This appears to be true for the majority of the wavelength range, although the ratio becomes somewhat noisy below about 2400 A.

The mean new-to-old calibration ratio is also listed in Table 1 in 10 A bins. Only the wavelength bins between 1910 A to 3300 A have been included in Table 1 due very noisy data outside this wavelength range. A bin size of 10 A was chosen, rather than the 25 A or 50 A bins of the new and old LWP absolute calibrations, because the five individual new-to-old ratios appeared to show repeatable variations on a wavelength scale smaller than the absolute calibrations. This

might be expected if the variations are due to ITF changes. Table 1 can be used to correct older LWP spectra, processed with ITF1 and the old absolute calibration, to the ITF2 and new absolute calibration scale. The corrected fluxes (Fc) are given simply by
Fc = Fold * Rint; where, Fold are the old calibration fluxes, and Rint are the correction factors determined by linear interpolation between the points in Table 1.

An IDL procedure (LWPFIX) using the above correction algorithm has been written and will soon be available at the GSFC RDAF.
A sample of the corrected fluxes for HD 60753 are shown in Figures 7 to 11. It can be seen that the overall level of the corrected fluxes agree reasonably well with the new calibration fluxes; however, differences still exhist on a point-to-point level. Thus, this correction algorithm works best for well exposed data between about 2400 A to 3100 A and is not appropriate for correction of spectra which are to be used to study weak features. Furthermore, due to differences in response between the large aperture and trailed spectra, this correction algorithm is most accurate for large-aperture point-source spectra. Spectra which do not meet these criteria are probably best reprocessed with the new LWP ITF and new absolute calibration rather than using this correction algorithm.

One problem that has been noted with the old LWP calibration was that the SWP and LWP fluxes did not match well in the wavelength overlap region between the two cameras. This problem has been reduced with the new LWP calibration. The new calibration LWP fluxes in the 1850 to 1950 A region are more in agreement with the Bohlin and Holm fluxes (see Figures 1 to 5), although they still appear to be slightly high for several stars (especially the 1850 and 1875 bins). Figure 12 compares the SWP/LWP overlap region for HD 60753 for both the old and new calibrations. The SWP fluxes were corrected for sensitivity decline using the preliminary correction algorithm of Gilmozzi and Rodriguez (1987). Although, the LWP data are quite noisy in this region, the new LWP calibration fluxes appear to match somewhat better and more smoothly with the SWP fluxes than the old calibration.

Summary

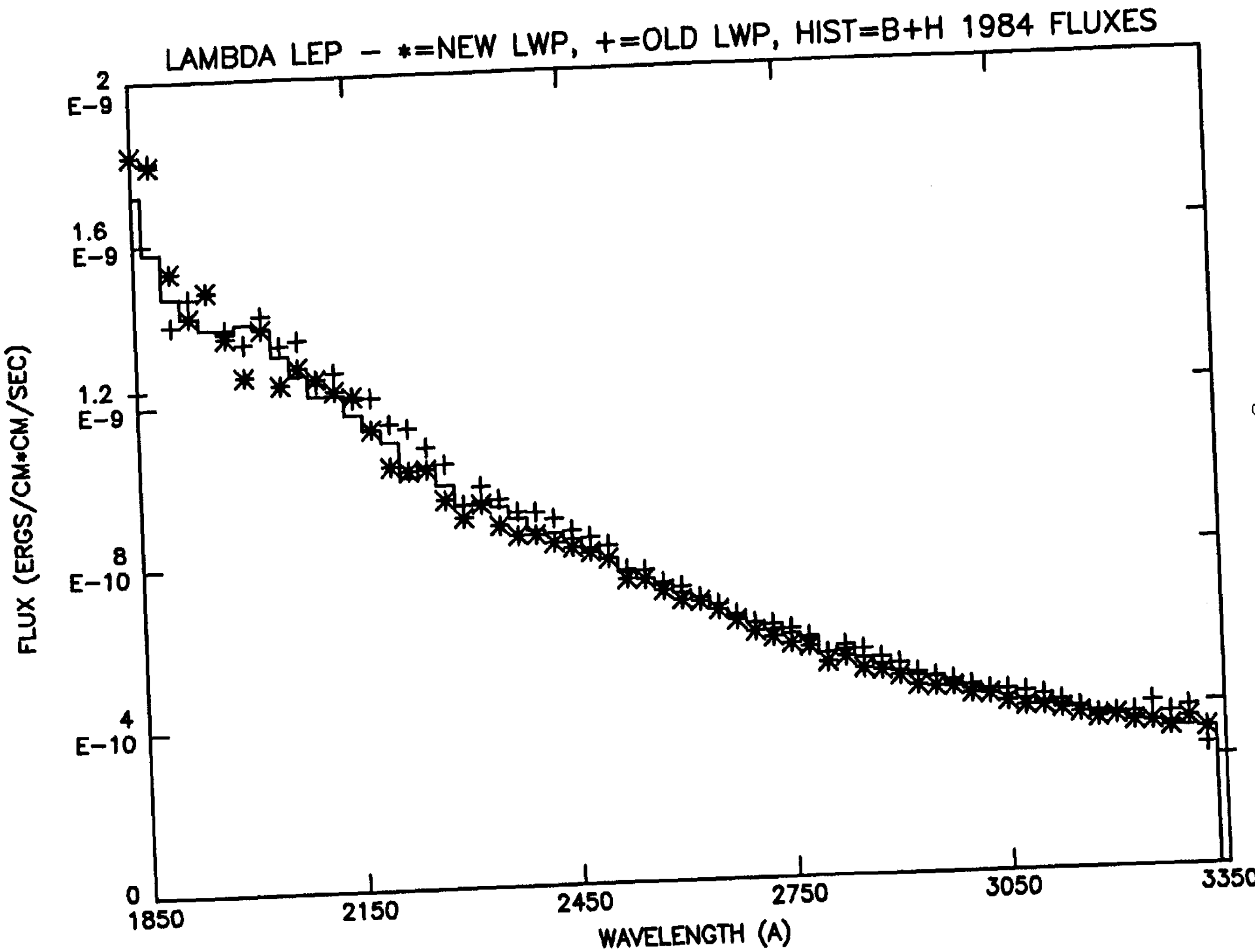
Spectra processed with the new LWP ITF and absolute calibration generally yield fluxes which are more accurate than when processed with the old LWP ITF and absolute calibration. The new flux scale is about 4 to 7% lower than the old flux scale, depending on wavelength. The SWP/LWP overlap problem is reduced with the new LWP calibrations.

References

Bohlin, R., and Holm, A. 1984, NASA IUE Newsletter, No. 24, 74.
Cassatella, A. and Lloyd, C. 1987, ESA IUE Newsletter, No. 27, 13.
Cassatella, A., Lloyd, C., and Gonzalez Riestra, R. 1987, Report presented at the November IUE Three-Agency Meeting.
Crenshaw, D. M. 1986, GSFC IUE Newsletter, No. 31, 37.
Gilmozzi, R., and Rodriguez, P. 1987, Report presented at the November IUE Three-Agency Meeting.
Imhoff, C. 1986, GSFC IUE Newsletter, No. 31, 11.
Nichols-Bohlin, J., and Scott, E. H. 1986, Report presented at the June IUE Three-Agency Meeting.
Oliversen, N. 1986, GSFC IUE Newsletter, No. 31, 52.
Oliversen, N. and Garhart, M. 1987, Report presented at the November IUE Three-Agency Meeting.
Sonneborn, G. 1984, GSFC IUE Newsletter, No. 24, 67.

Table 1 - Ratio of New to Old LWP Absolute Calibration

Wavelength	Ratio	Wavelength	Ratio	Wavelength	Ratio
1910.00	0.919	2390.00	0.929	2870.00	0.924
1920.00	0.784	2400.00	0.962	2880.00	0.929
1930.00	0.897	2410.00	0.936	2890.00	0.936
1940.00	0.869	2420.00	0.945	2900.00	0.949
1950.00	0.865	2430.00	0.915	2910.00	0.941
1960.00	1.103	2440.00	0.956	2920.00	0.947
1970.00	0.998	2450.00	0.942	2930.00	0.931
1980.00	0.926	2460.00	0.991	2940.00	0.954
1990.00	0.990	2470.00	0.929	2950.00	0.948
2000.00	0.940	2480.00	0.953	2960.00	0.959
2010.00	1.037	2490.00	0.954	2970.00	0.979
2020.00	1.079	2500.00	0.973	2980.00	0.963
2030.00	1.022	2510.00	0.930	2990.00	0.952
2040.00	0.968	2520.00	0.975	3000.00	0.951
2050.00	0.926	2530.00	0.963	3010.00	0.965
2060.00	0.907	2540.00	0.940	3020.00	0.956
2070.00	0.935	2550.00	0.951	3030.00	0.944
2080.00	0.937	2560.00	0.989	3040.00	0.932
2090.00	0.995	2570.00	0.974	3050.00	0.883
2100.00	1.017	2580.00	0.945	3060.00	0.975
2110.00	0.960	2590.00	0.939	3070.00	0.951
2120.00	0.917	2600.00	0.966	3080.00	0.943
2130.00	0.948	2610.00	0.964	3090.00	0.954
2140.00	0.959	2620.00	0.982	3100.00	0.952
2150.00	0.974	2630.00	0.945	3110.00	0.950
2160.00	0.987	2640.00	0.973	3120.00	0.971
2170.00	0.952	2650.00	0.972	3130.00	0.972
2180.00	0.976	2660.00	0.969	3140.00	0.948
2190.00	0.955	2670.00	0.966	3150.00	0.967
2200.00	1.006	2680.00	0.965	3160.00	0.973
2210.00	0.905	2690.00	0.997	3170.00	0.994
2220.00	0.889	2700.00	0.946	3180.00	1.042
2230.00	0.940	2710.00	0.941	3190.00	1.036
2240.00	1.004	2720.00	0.932	3200.00	0.973
2250.00	0.948	2730.00	0.932	3210.00	1.025
2260.00	0.941	2740.00	0.949	3220.00	0.919
2270.00	0.929	2750.00	0.924	3230.00	0.973
2280.00	0.953	2760.00	0.949	3240.00	0.963
2290.00	1.021	2770.00	0.936	3250.00	0.842
2300.00	0.982	2780.00	0.952	3260.00	0.915
2310.00	0.957	2790.00	0.963	3270.00	0.918
2320.00	0.930	2800.00	0.939	3280.00	0.907
2330.00	0.928	2810.00	0.947	3290.00	1.039
2340.00	0.982	2820.00	0.935	3300.00	0.827
2350.00	0.942	2830.00	0.941		
2360.00	0.982	2840.00	0.924		
2370.00	0.976	2850.00	0.892		
2380.00	0.908	2860.00	0.916		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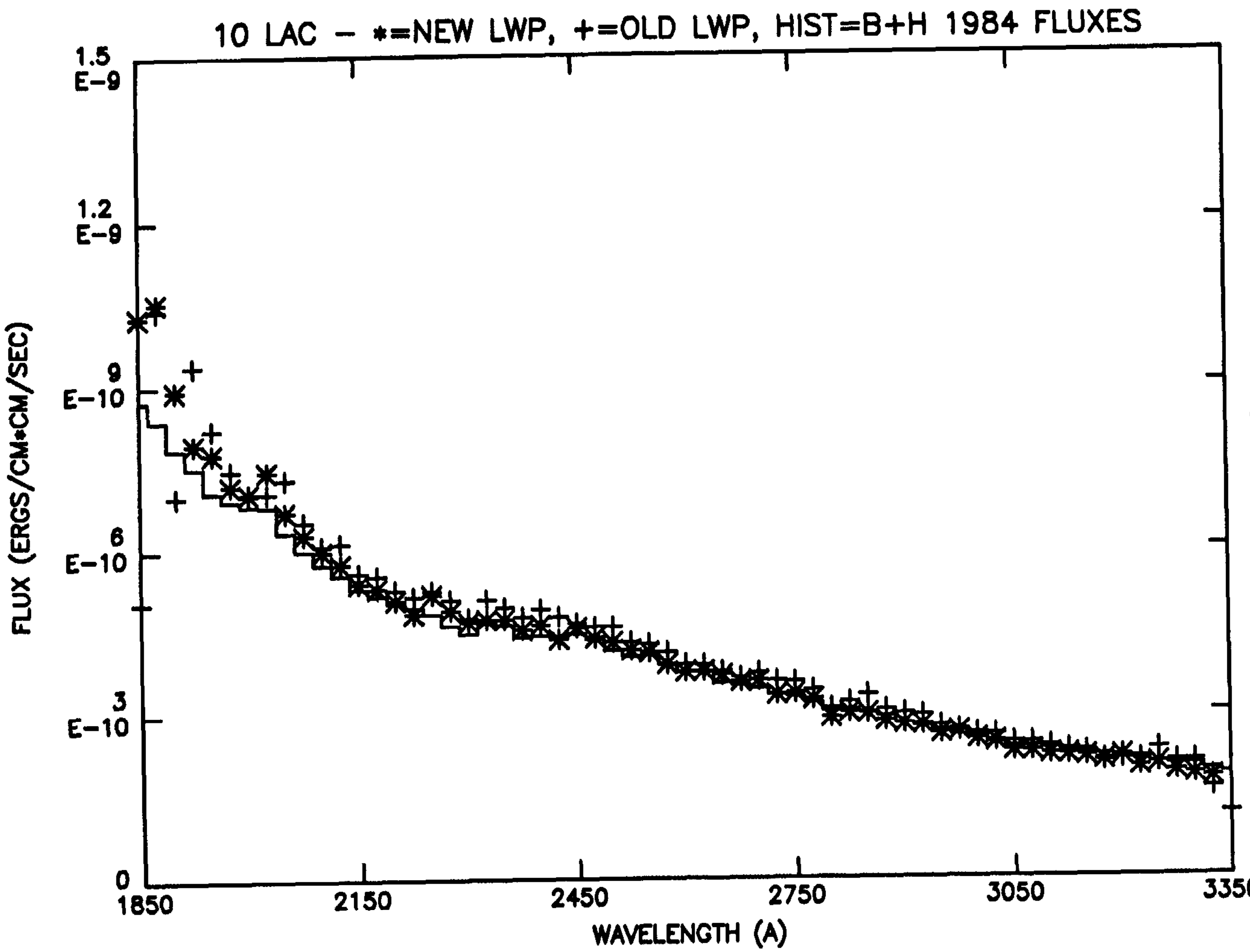
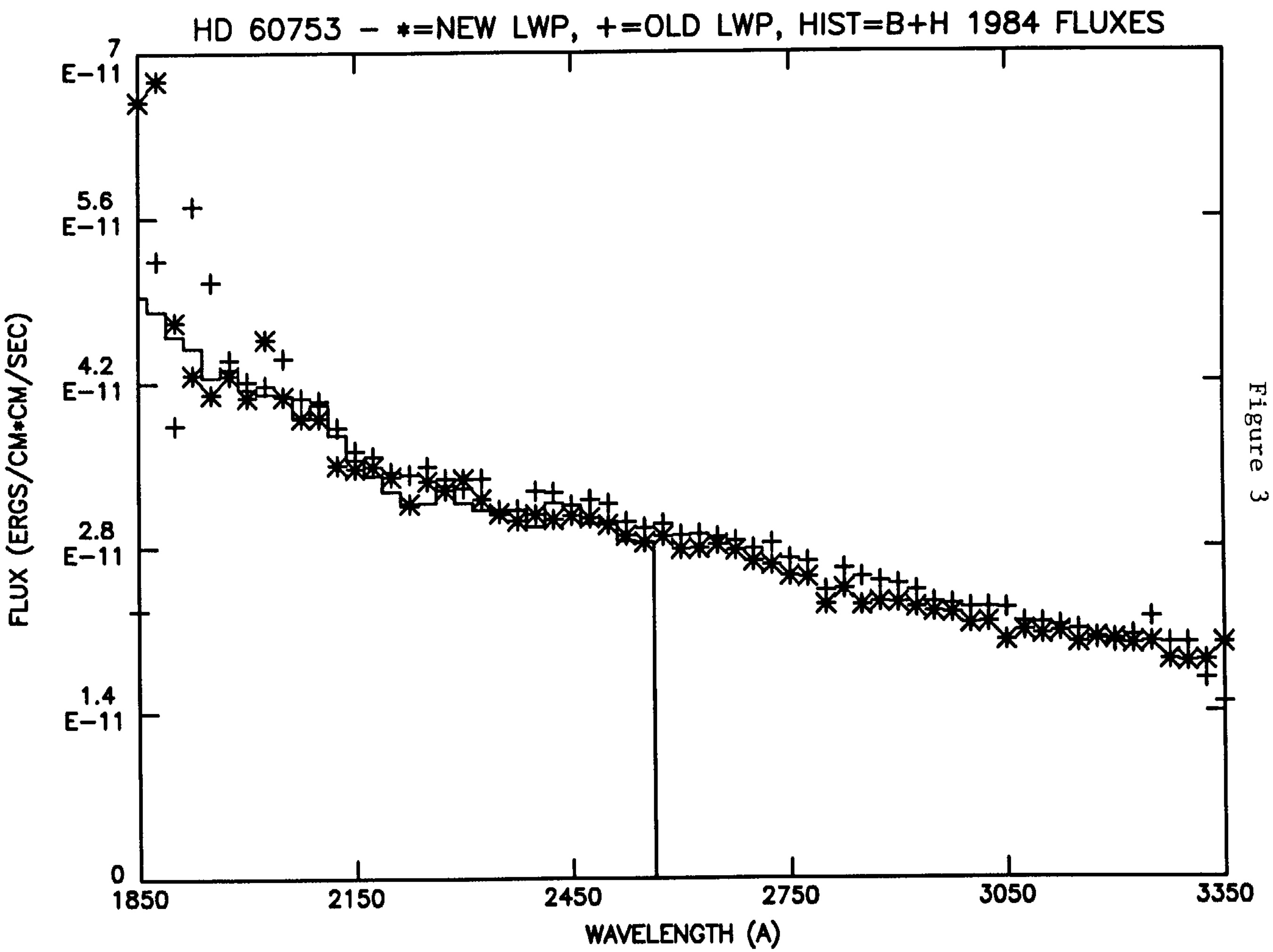
2 E-9
1.6 E-9
1.2 E-9
8 E-10
4 E-10
0
1850
2150
2450
2750
3050
3350
WAVELENGTH (A)

Figure 1



10 LAC – *=NEW LWP, +=OLD LWP, HIST=B+H 1984 FLUXES
FLUX (ERGS/CM/CM*CM/SEC)
1.5 E-9
1.2 E-9
9 E-10
6 E-10
3 E-10
0
1850
2150
2450
2750
3050
3350
WAVELENGTH (A)

Figure 2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FLUX (ERGS/CM*CM/SEC)
7 E-11
5.6 E-11
4.2 E-11
2.8 E-11
1.4 E-11
0
1850
2150
2450
2750
3050
3350
WAVELENGTH (A)

Figure 3

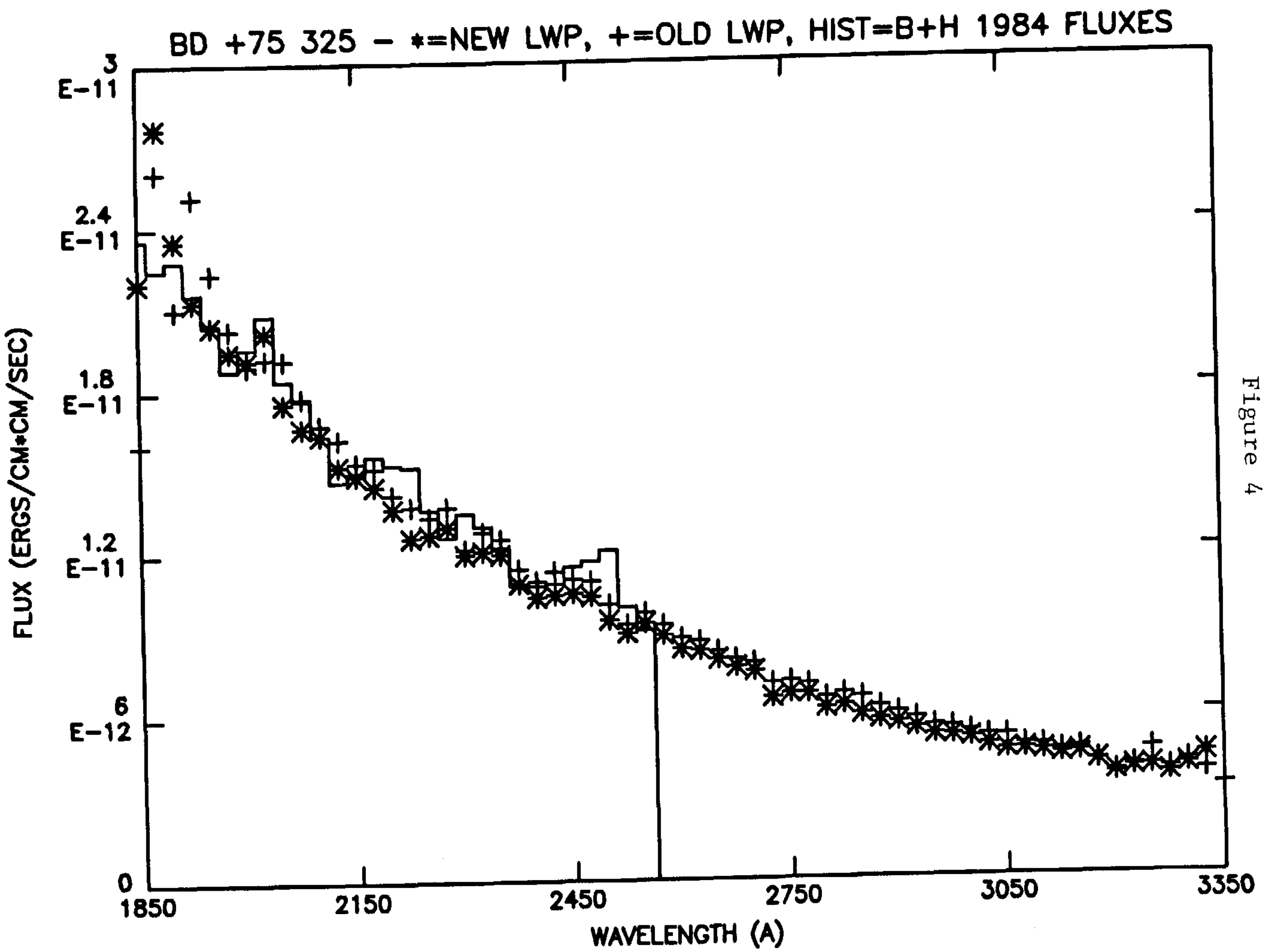
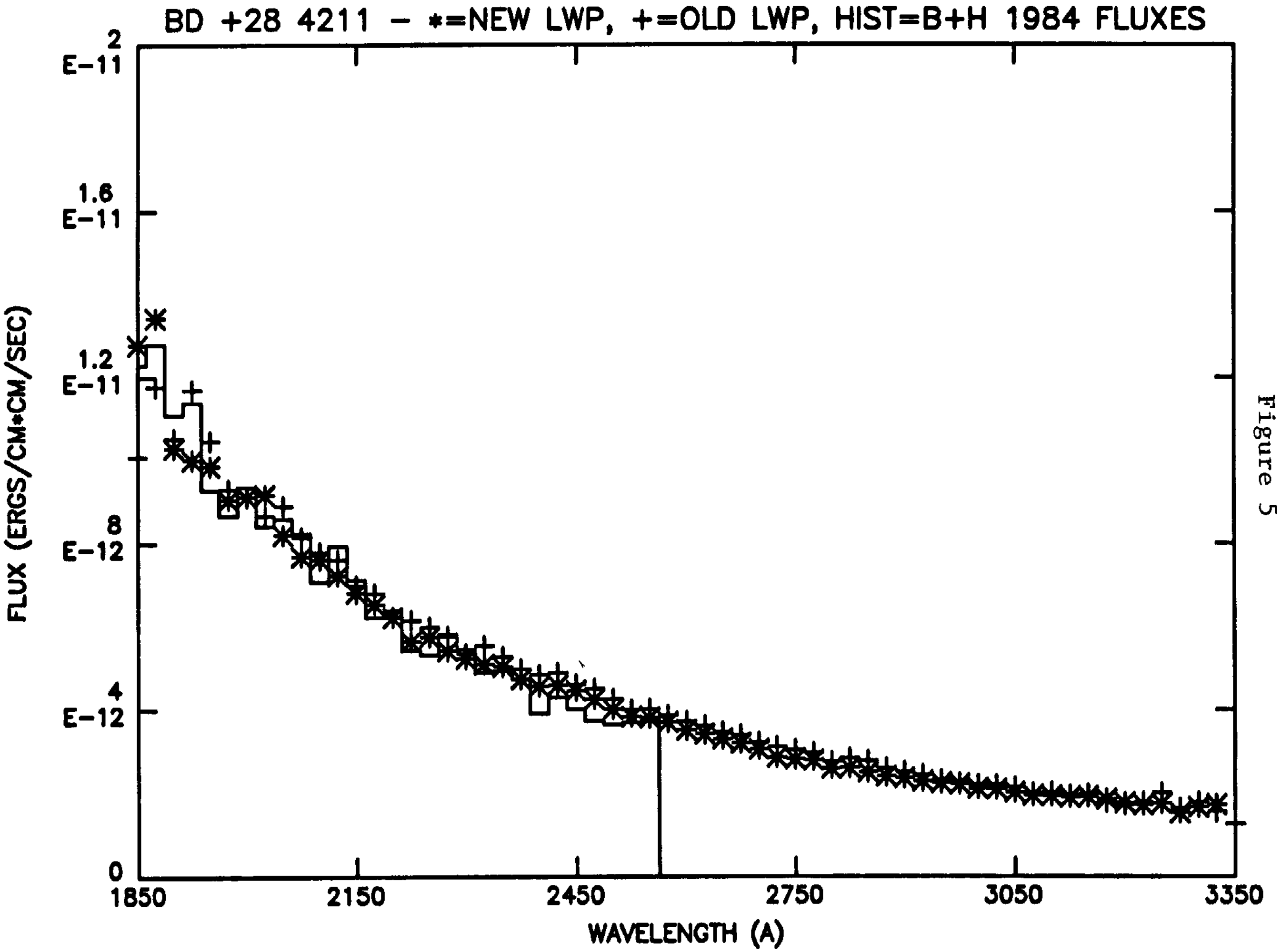

BD +75 325 - *=NEW LWP, +=OLD LWP, HIST=B+H 1984 FLUXES
FLUX (ERGS/CM*CM/SEC)
3 E-11
2.4 E-11
1.8 E-11
1.2 E-11
6 E-12
0
1850
2150
2450
2750
3050
3350
WAVELENGTH (A)

Figure 4



BD +28 4211 - *=NEW LWP, +=OLD LWP, HIST=B+H 1984 FLUXES
FLUX (ERGS/CM*CM/SEC)
2 E-11
1.6 E-11
1.2 E-11
8 E-12
4 E-12
0
1850
2150
2450
2750
3050
3350
WAVELENGTH (A)

Figure 5

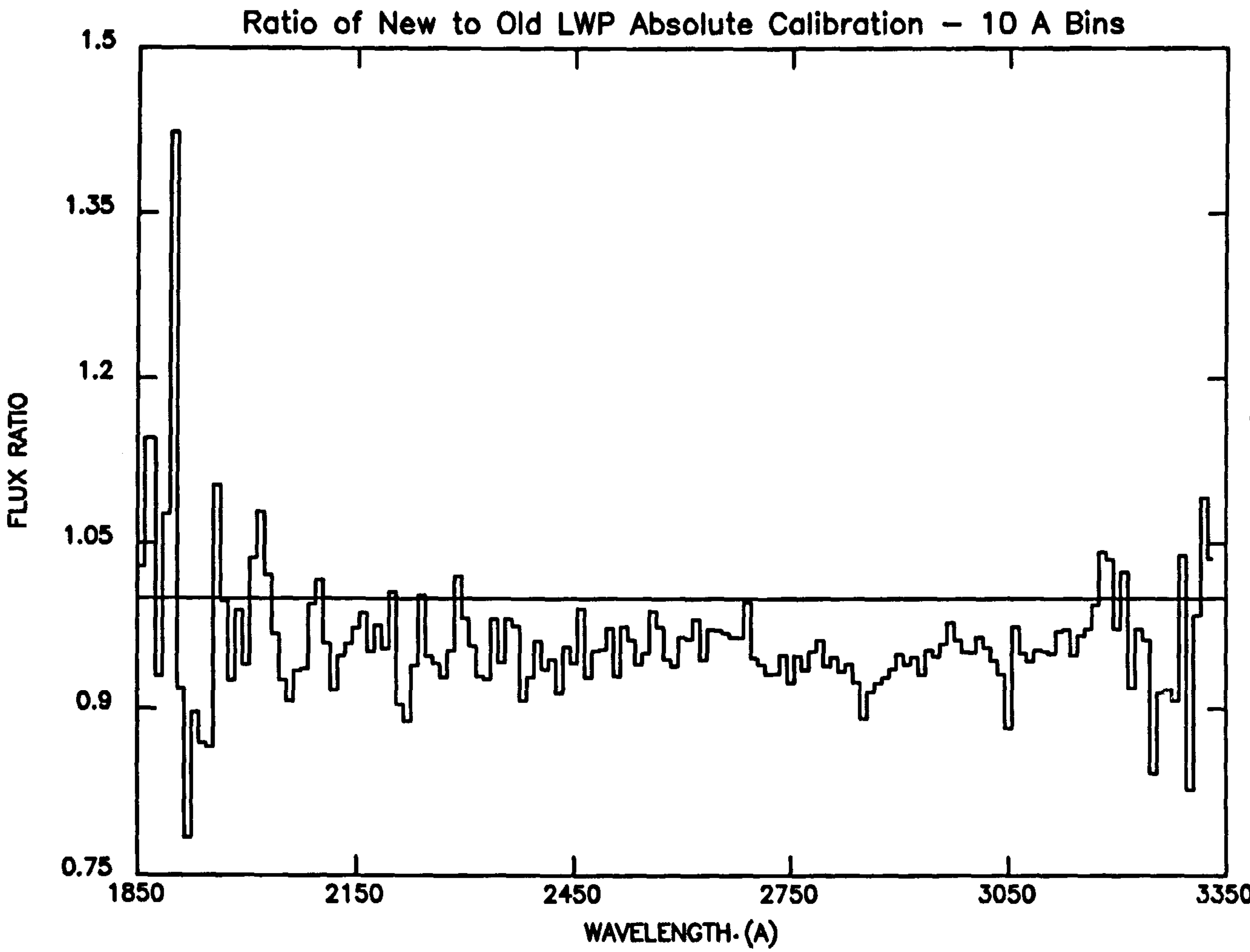
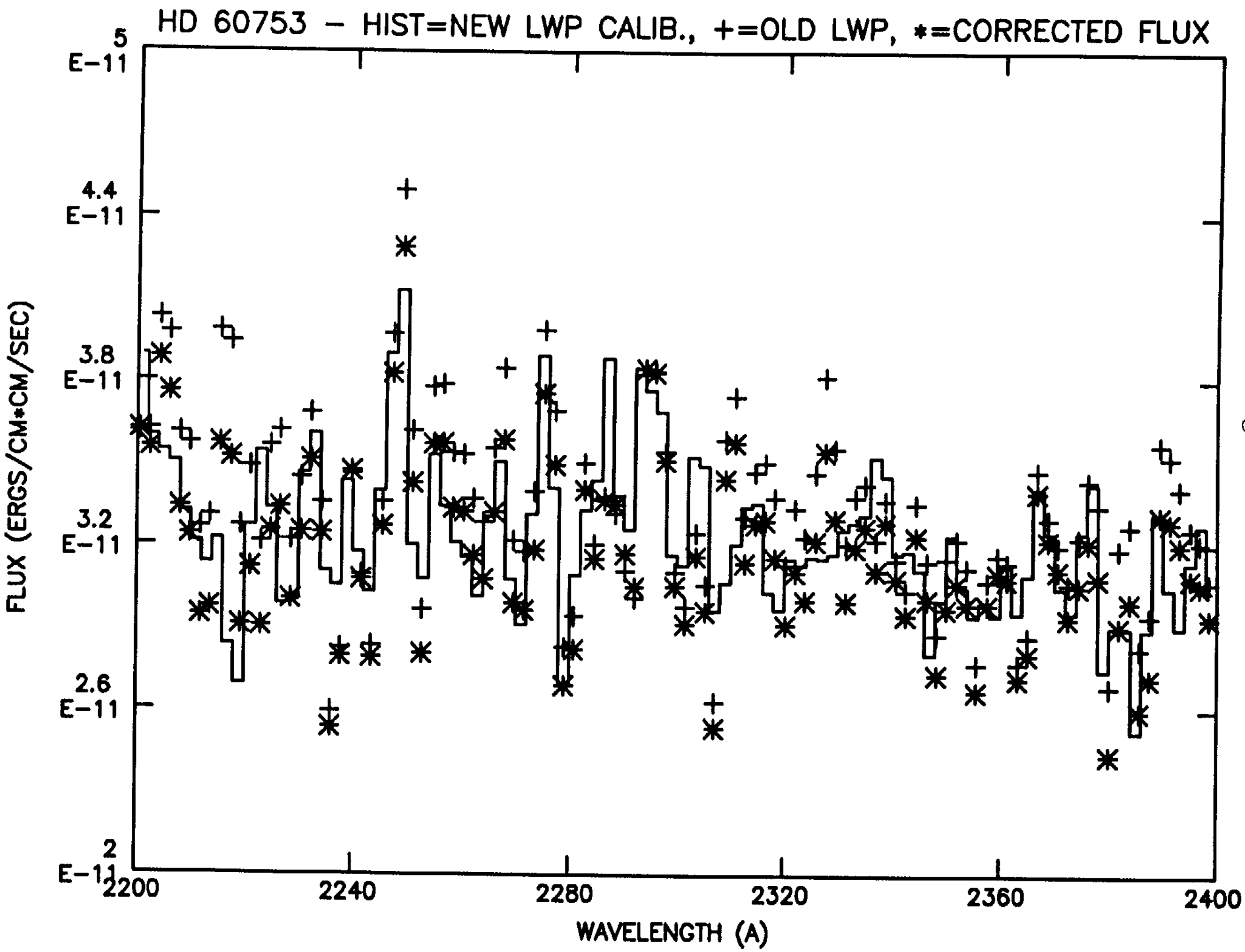

Ratio of New to Old LWP Absolute Calibration – 10 A Bins
1.5
1.35
1.2
1.05
0.9
0.75
FLUX RATIO
1850
2150
2450
2750
3050
3350
WAVELENGTH· (A)

Figure 6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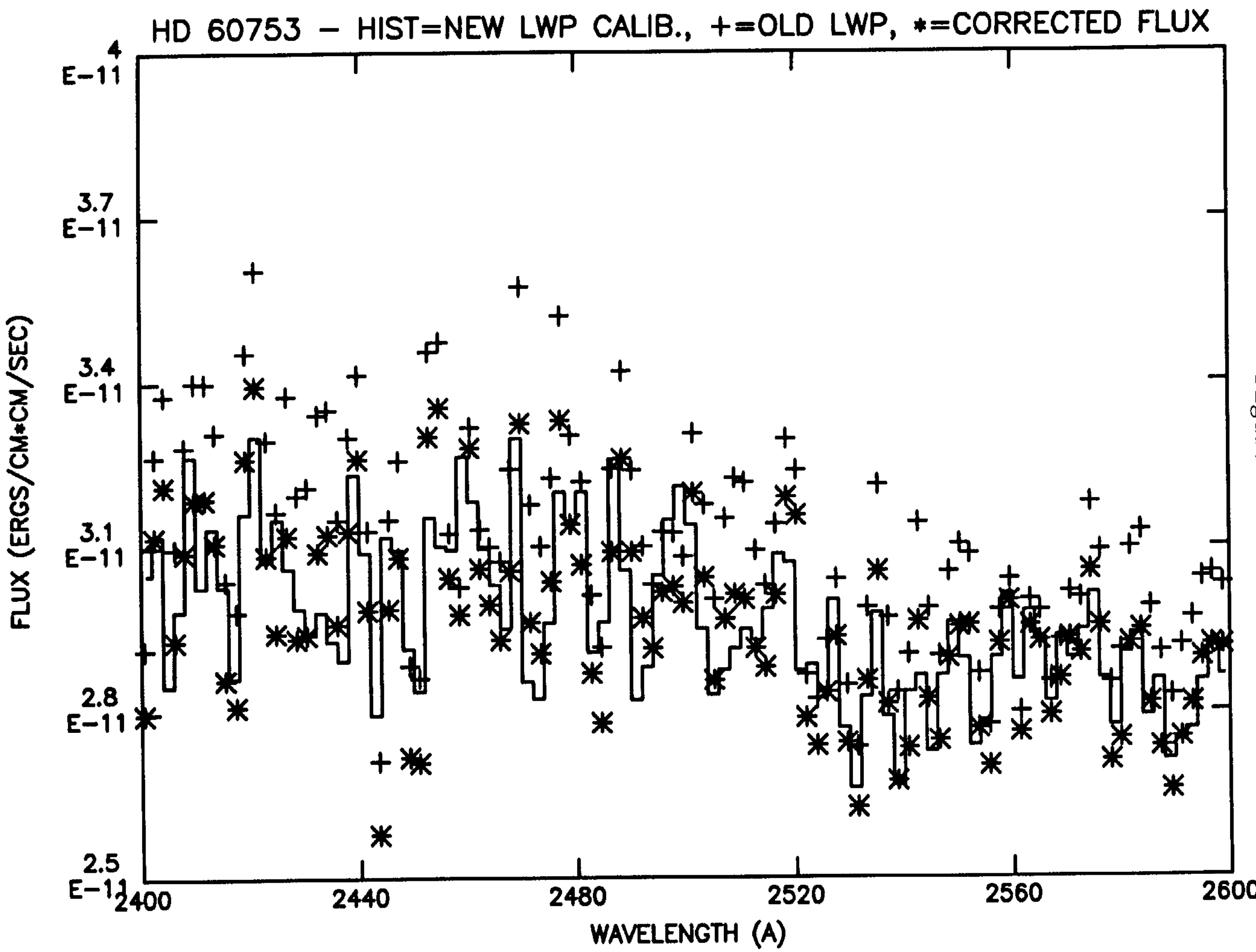
FLUX (ERGS/CM*CM/SEC)
5 E-11
4.4 E-11
3.8 E-11
3.2 E-11
2.6 E-11
2 E-11
2200
2240
2280
2320
2360
2400
WAVELENGTH (A)

Figure 7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FLUX (ERGS/CM*CM/SEC)
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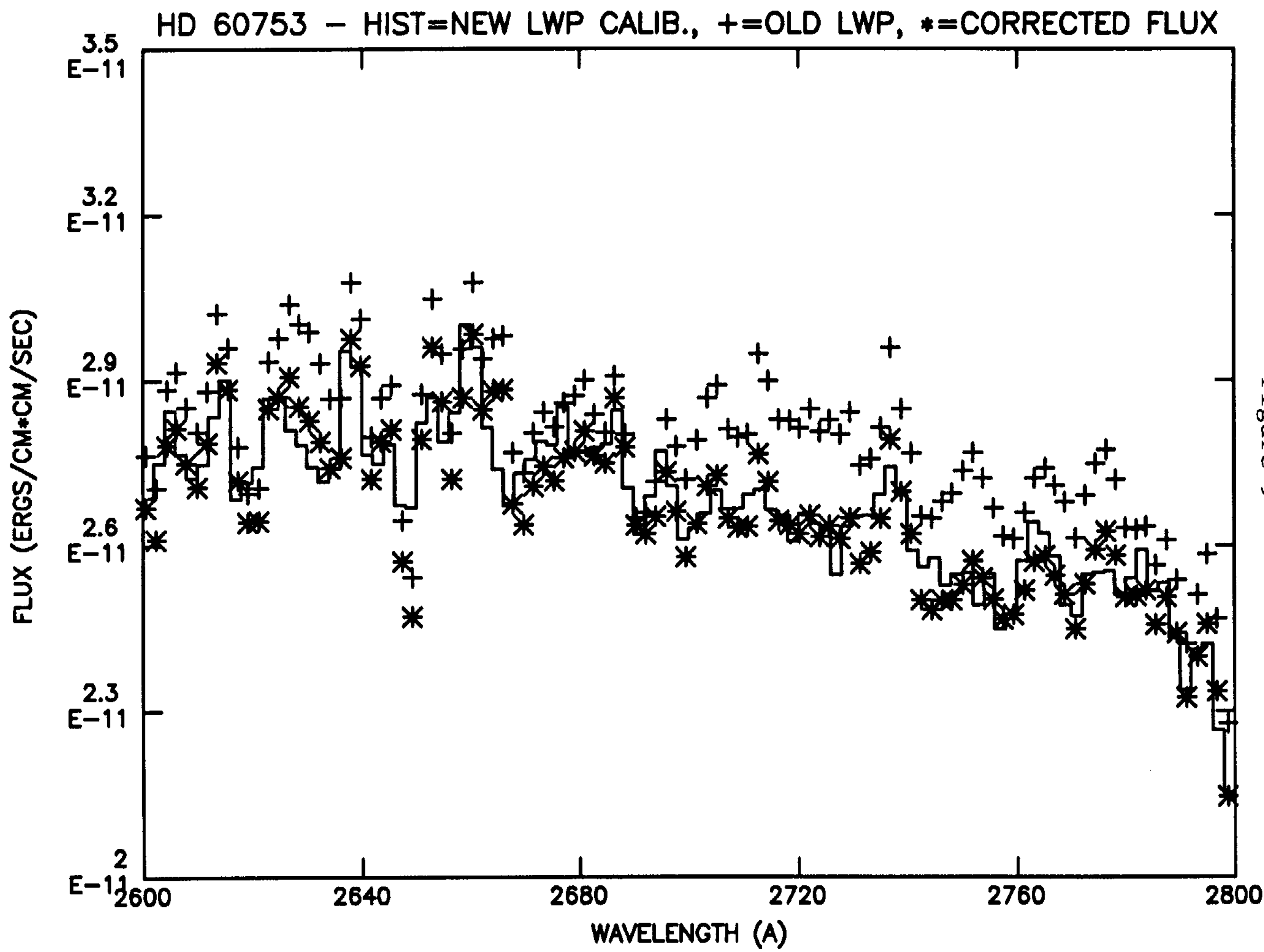
3.7 E-11
3.4 E-11
3.1 E-11
2.8 E-11
2.5 E-11
2400
2440
2480
2520
2560
2600
WAVELENGTH (A)

Figure 8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FLUX (ERGS/CM*CM*CM/SEC)
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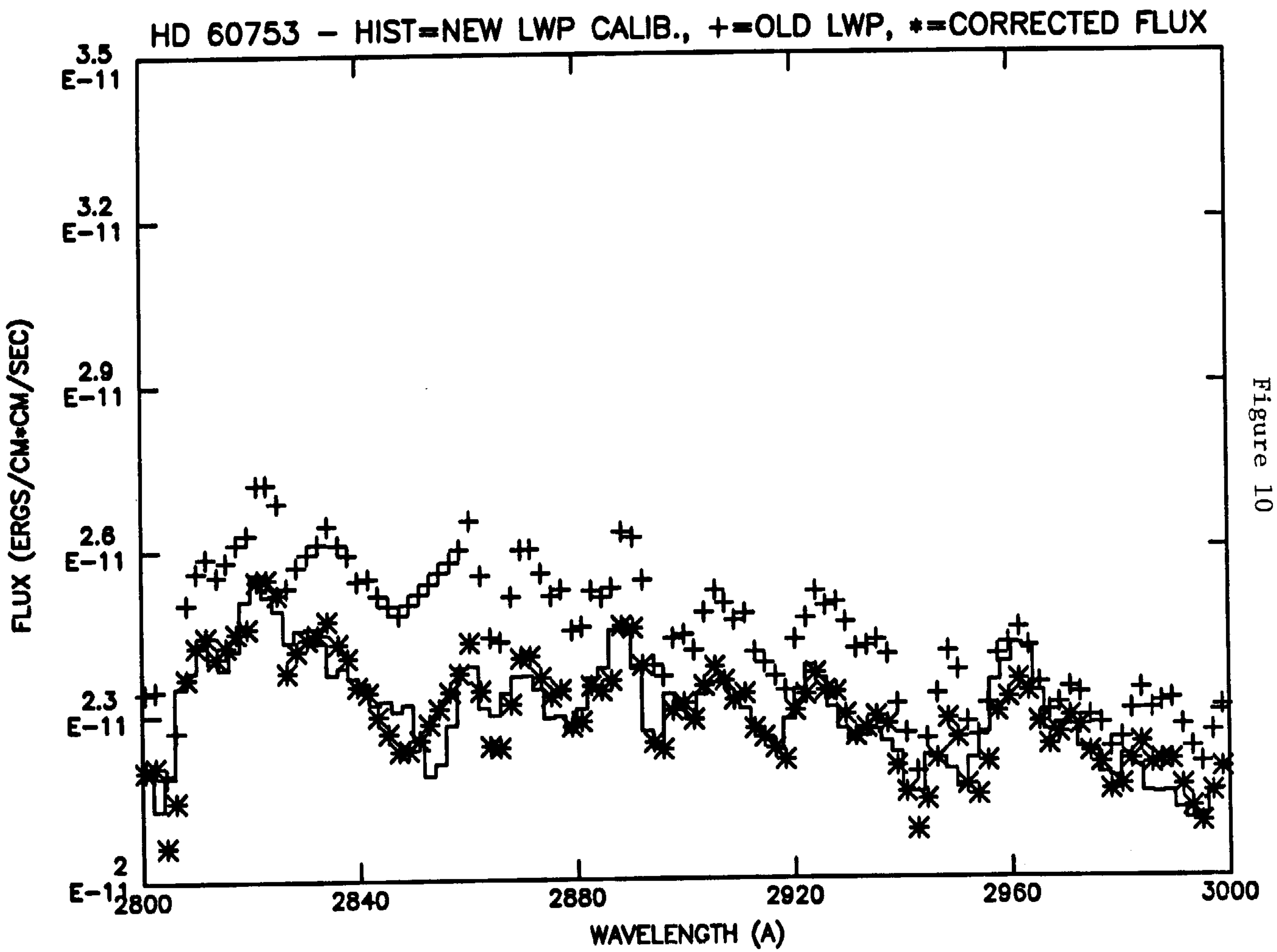
3.2 E-11
2.9 E-11
2.6 E-11
2.3 E-11
2 E-11
2600
2640
2680
2720
2760
2800
WAVELENGTH (A)

Figure 9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FLUX (ERGS/CM*CM*CM/SEC)
3.5 E-11
3.2 E-11
2.9 E-11
2.6 E-11
2.3 E-11
2 E-11
2800
2840
2880
2920
2960
3000
WAVELENGTH (A)

Figure 10

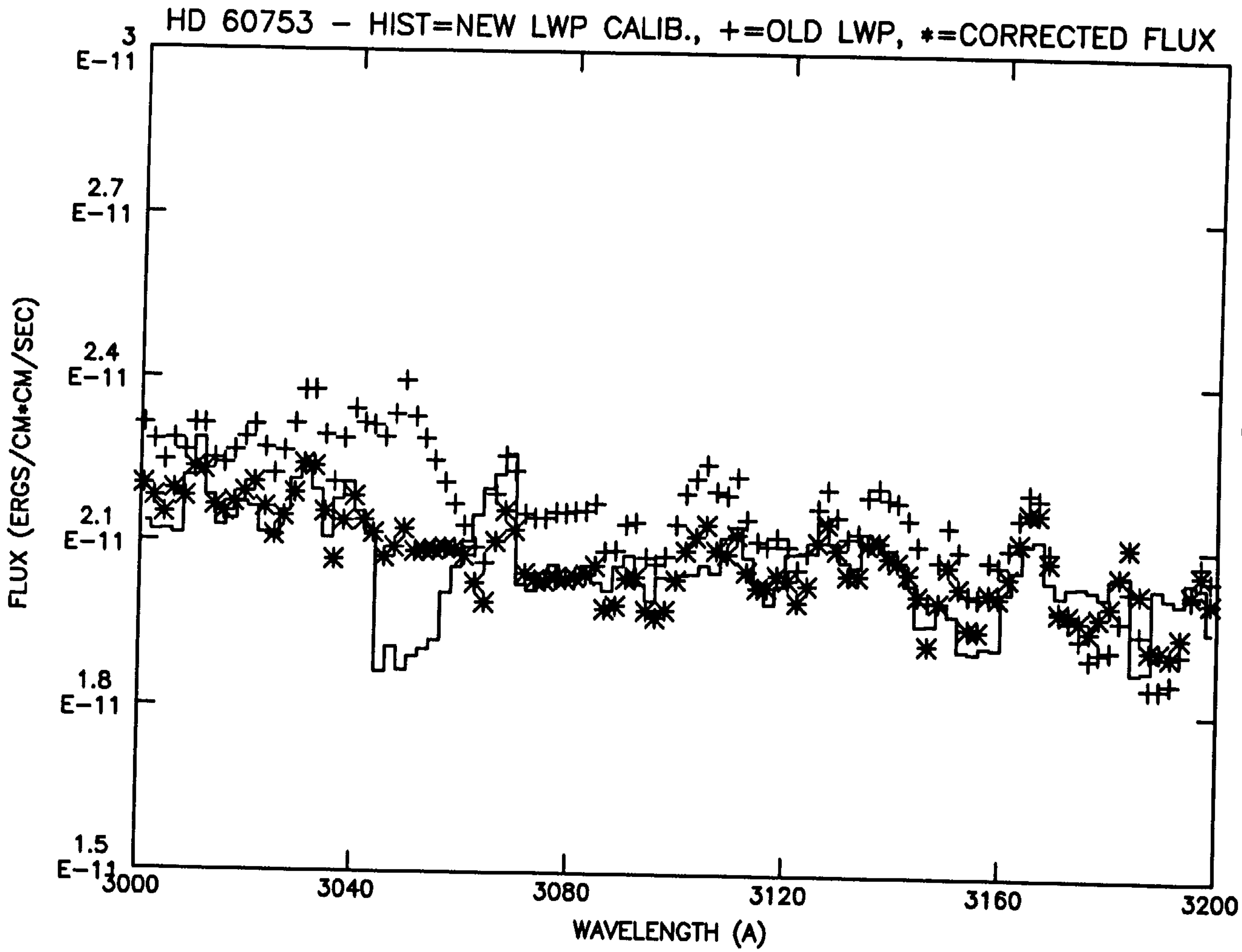

HD 60753 - HIST=NEW LWP CALIB., +=OLD LWP, *=CORRECTED FLUX
FLUX (ERGS/CM*CM*CM/SEC)
3 E-11
2.7 E-11
2.4 E-11
2.1 E-11
1.8 E-11
1.5 E-11
3000
3040
3080
3120
3160
3200
WAVELENGTH (A)

Figure 11

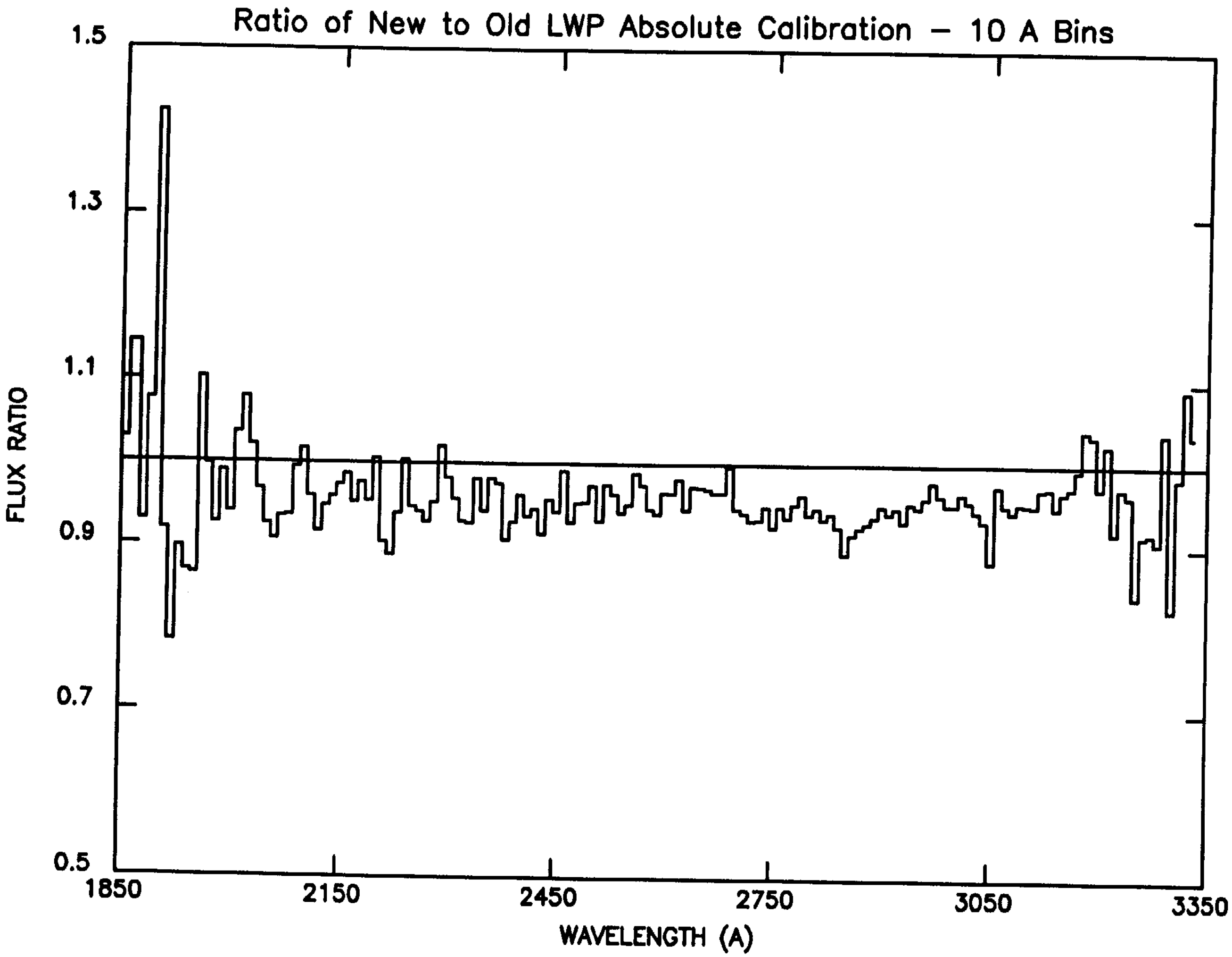
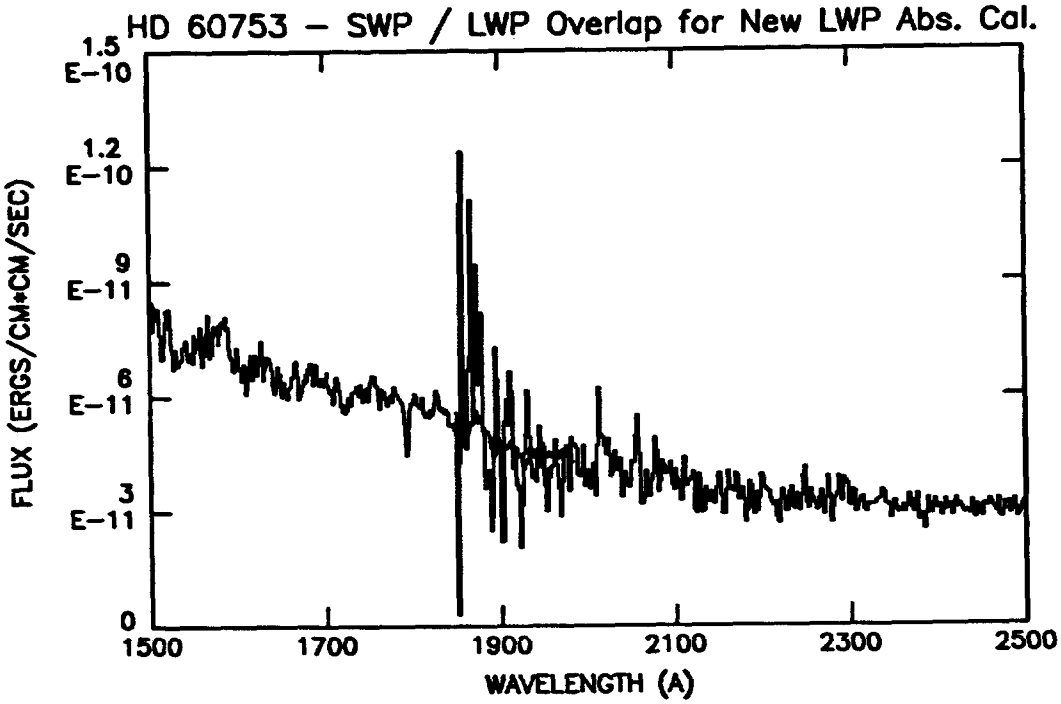
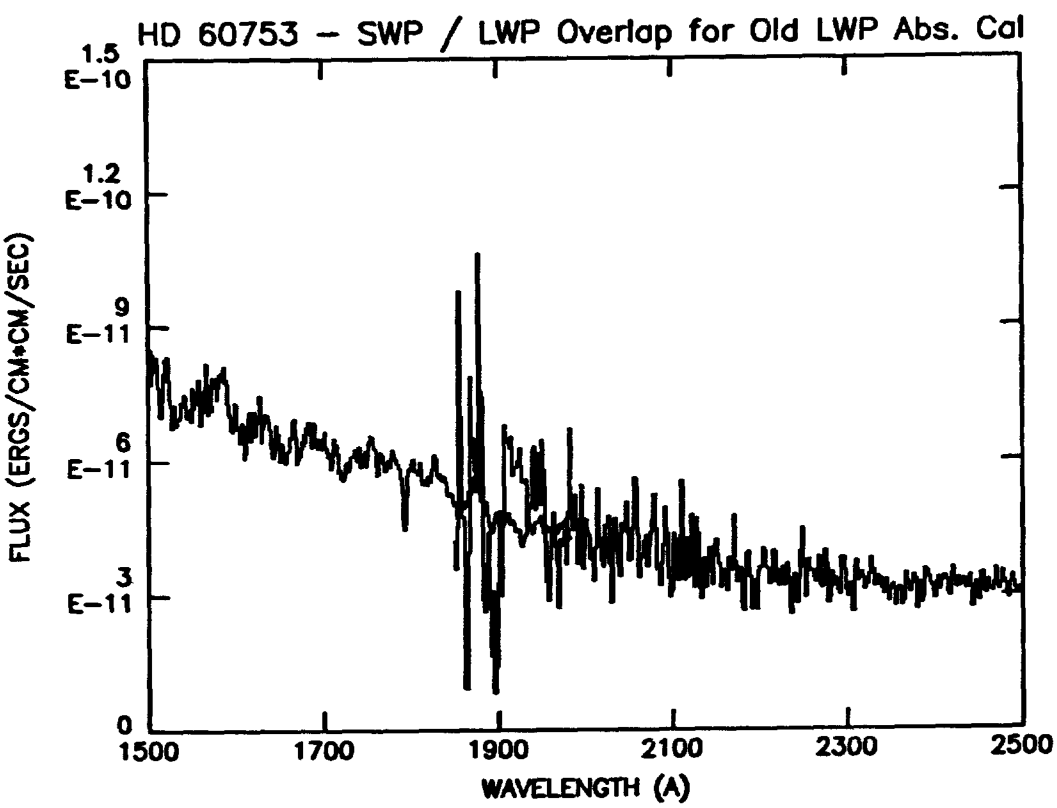

Ratio of New to Old LWP Absolute Calibration - 10 A Bins
1.5
1.3
1.1
0.9
0.7
0.5
FLUX RATIO
1850
2150
2450
2750
3050
3350
WAVELENGTH (A)

Figure 12


HD 60753 – SWP / LWP Overlap for New LWP Abs. Cal.
1.5 E-10
1.2 E-10
9 E-11
6 E-11
3 E-11
0
FLUX (ERGS/CM*CM/SEC)
1500
1700
1900
2100
2300
2500
WAVELENGTH (A)


HD 60753 – SWP / LWP Overlap for Old LWP Abs. Cal
1.5 E-10
1.2 E-10
9 E-11
6 E-11
3 E-11
0
FLUX (ERGS/CM*CM/SEC)
1500
1700
1900
2100
2300
2500
WAVELENGTH (A)