SCATTERED LIGHT From BRIGHT EMISSION LINES Preliminary Version Calibration Plan 12B

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Abstract

Scattered light levels are obtained by observing emission lines. At a distance of 50 diodes from the spectral lines the scattered light ranges from 1×10^{-5} to 4×10^{-5} that of the peak count rates. Upper limits to scattered light at 2 diodes from the lines range from 7×10^{-3} to 1×10^{-2} the peak count rates. An anomalous feature on the blue tube with a periodic structure of 4 diodes is not understood.

I. *Introduction*

A mercury discharge tube is observed and its spectra obtained with both tubes. Three narrow bandpass filters ($\approx$ 100Å FWHM) are used to isolate bright lines at 2537, 3458, and 5461Å. Long and short exposures are obtained of each line using several gratings. Transmission curves for the filters are determined using continuum lamps.

II. *Mercury Spectra*

For each Digicon detector, four mercury spectra were obtained through the A4 aperture. Exposures of 5s were made with gratings H19, H27, H40, and H57 on the blue tube. On the red tube, exposures of 1, 15, 40, and 10s were made with gratings H27, H40, H57, and H78, respectively. The concatenated spectra from the blue and red tubes are shown as Figures 1 and 2, respectively. Identified lines are labeled with their air wavelengths from the MIT wavelength tables. The blue spectra show identifiable lines from 1942 to 5791Å and the red spectra show lines from 2481 to 7945Å. The spectra from H40 for both tubes show a continuum from 3500 to 4600Å. The bright UV line at 2537Å on the blue tube has overflowed the 16 bit counter but a shorter exposure through the 2537 filter implies a peak of about 480,000c/s.

III. *Scattered Light*

Transmission curves for the three interference filters are obtained by taking the spectra of continuum sources with and without the filters (for example see Figure 3). The *expected* spectra are obtained from the product of the mercury spectra and the transmission curves. Subtracting the expected spectra from the observed, long exposure, filter spectra yields the scattered light (see Figure 4).

The short exposure spectra are used to estimate scattered light in the region 2 to 20 diodes from the mercury lines. Subraction of the expected spectra was not possible for these exposures due to insufficient counting statistics. However, the spectra are upper limits on the scattered light. Figure 5 shows the profile of mercury line 4358Å observed on the red tube through the 4358 filter. At two diodes from the line center the profile agrees with the requirements specified in the FOS design. From 6 to 20 diodes the profile is greater than the specifications by about a factor of 2. Since the FWHM transmission of the filter is 38 diodes for H40, the continuum in Figure 2, which is 10^{-3} times the level of line 4358Å, may dominate the profile so that the actual scattering in the near wings may be well below the the upper limits in Figure 5. The scattering in the far wings shown in Figure 4, bottom plot, is typical for both tubes and for gratings H27, H40, and H57. In all cases the scattered light is well below the design specifications of 2×10^{-4} at 50 diodes and 1×10^{-4} beyond 100 diodes from the line center.

IV. *Anomalies*

In eight spectra from the blue tube, periodic features are present, examples of which are shown in Figure 6. In all eight cases the period of the features is between 4.0 and 4.12 diodes and the distance from the emission line approximately 270 diodes. Since the features appear on spectra taken with H27, H40, L15, the prism, and the camera mirror, with filters 2537 and 4358, the anomalies seem to be independent of grating, filter, and wavelength, thus, suggesting an origin within the Digicon. For the H27 spectrum in Figure 6 the maximum level of the anomaly is 2×10^{-5} of the total count rate. No anomalous features are observed from red tube spectra. However, the thermonic dark count of 0.33 c/s at ambient temperature may mask any such features on the red tube. Power spectrum analysis will be performed on red spectra to see if such anomalies do indeed exist.

Figure Captions

Figure 1. Mercury spectrum from the blue tube. Lines are labeled with their air wavelengths from the MIT wavelength tables. The FOS entrance aperture was 0.1 arcsec(A4), so that the resolution is $R \approx 1300$ as determined by the 0.35arcsec diode size.

Figure 2. Red tube mercury spectrum as for Figure 1.

Figure 3. The blue tube spectrum of a tungsten lamp on grating H40 is shown in the upper plot. Two bad diodes have not had their counting rate corrected. The lower plot shows the transmission curve as a function of wavelength for filter 4358. The curve is the ratio of the lamp intensity to the intensity of the lamp transmitted by the filter. The bump near 3700Å is apparently a filter leak.

Figure 4. The upper plot shows: a) the spectrum of mercury line 4358Å observed through the 4358 filter, and b) the expected spectrum obtained by multiplying the mercury spectrum (Fig. 2) by the transmission curve (Fig. 3) of the 4358 filter. The lower plot is obtained by subtracting both curve b and 0.33c/s dark signal from curve a and dividing the result by the total count rate. The plot represents the fractional scattered light for the region outside of the filter bandpass. The negative difference near the 4358Å line is probably caused by inaccuracies in the preliminary paired pulse correction.

Figure 5. Line profile of the 4358Å mercury line normalized to the total count rate. Upper limits to the scattered light near the peak may be read directly from the plot. The design specifications for the scattered light are shown as (+).

Figure 6. Periodic anomalies from spectra taken with H27 and the Camera mirror.

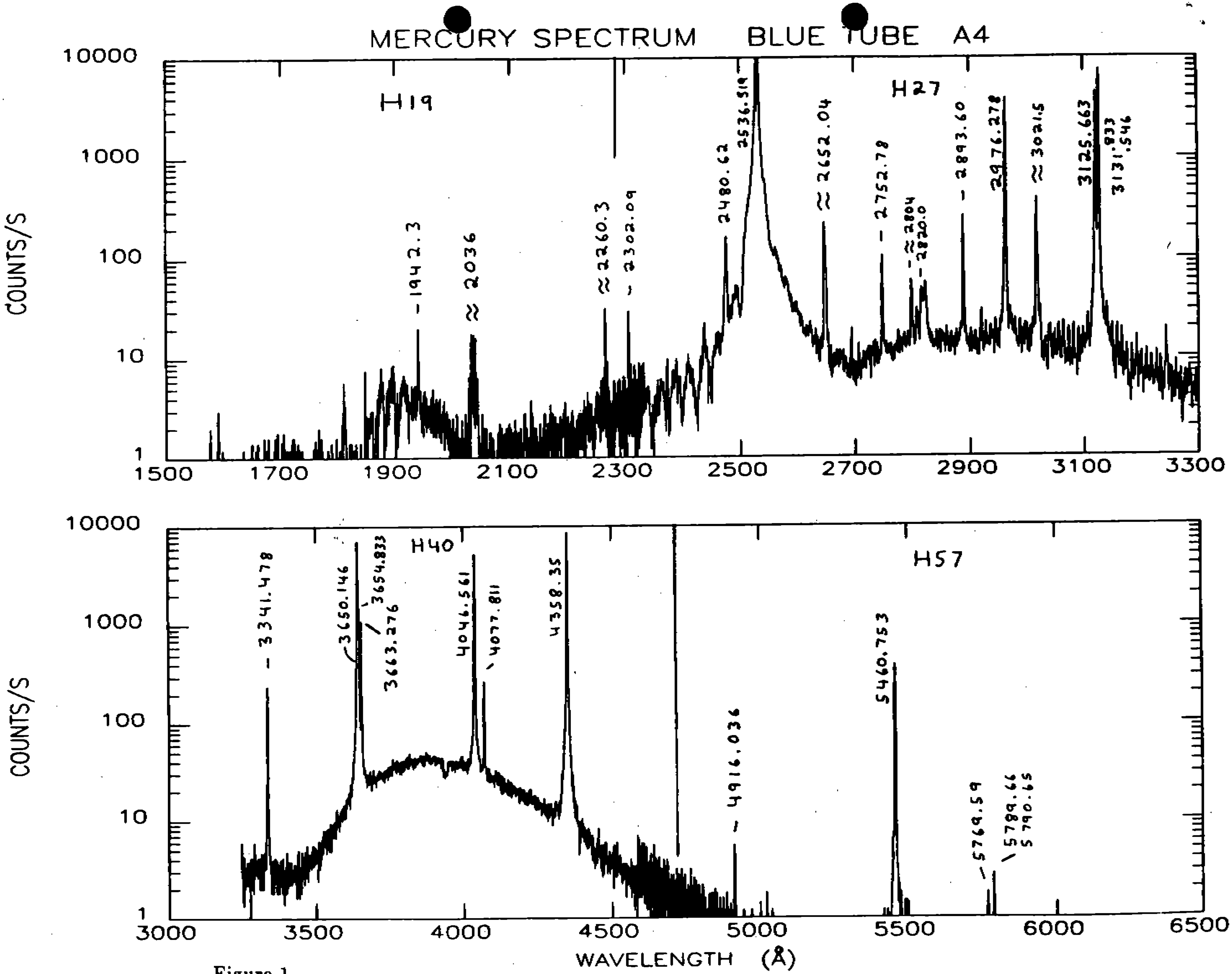
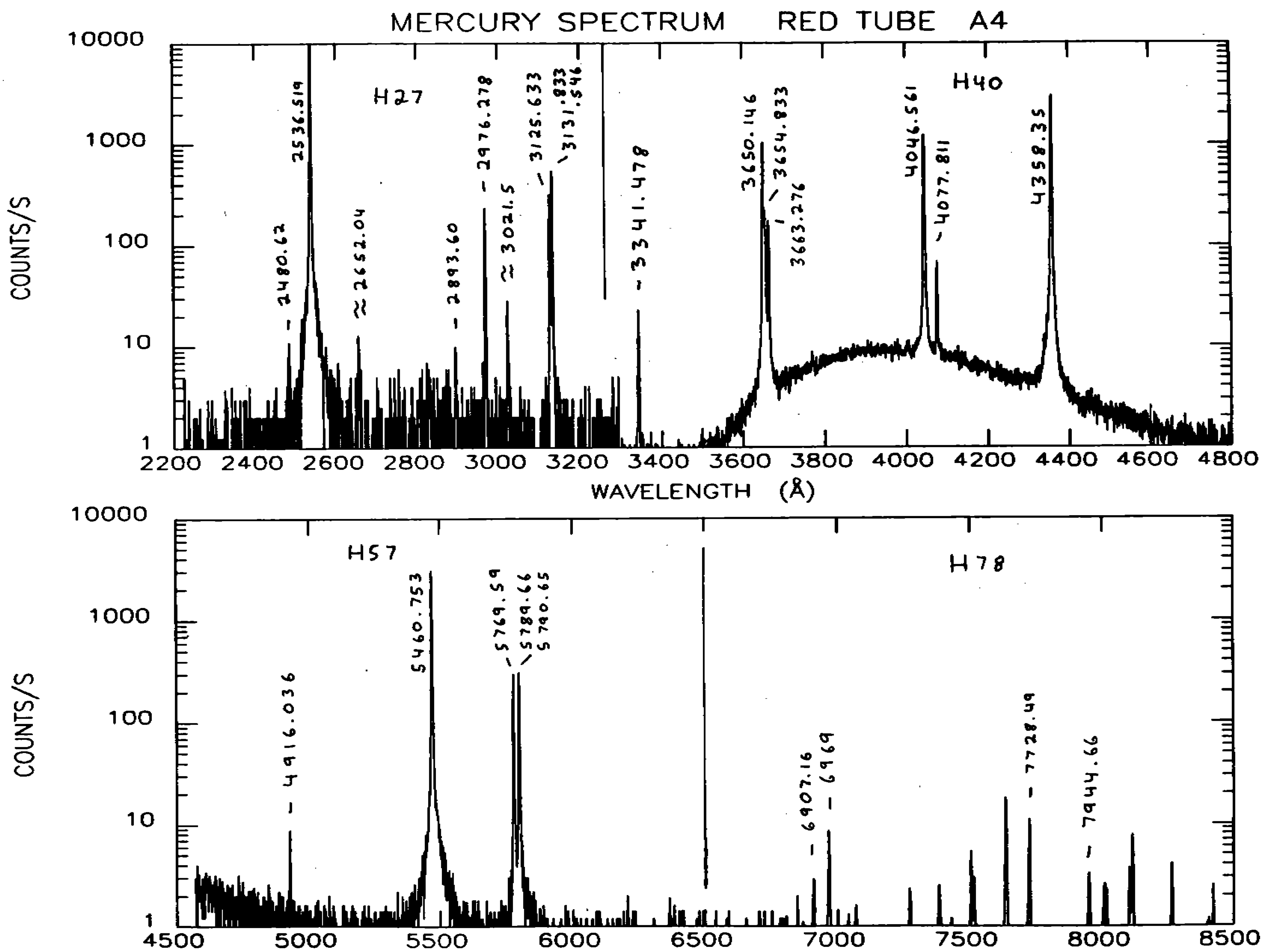
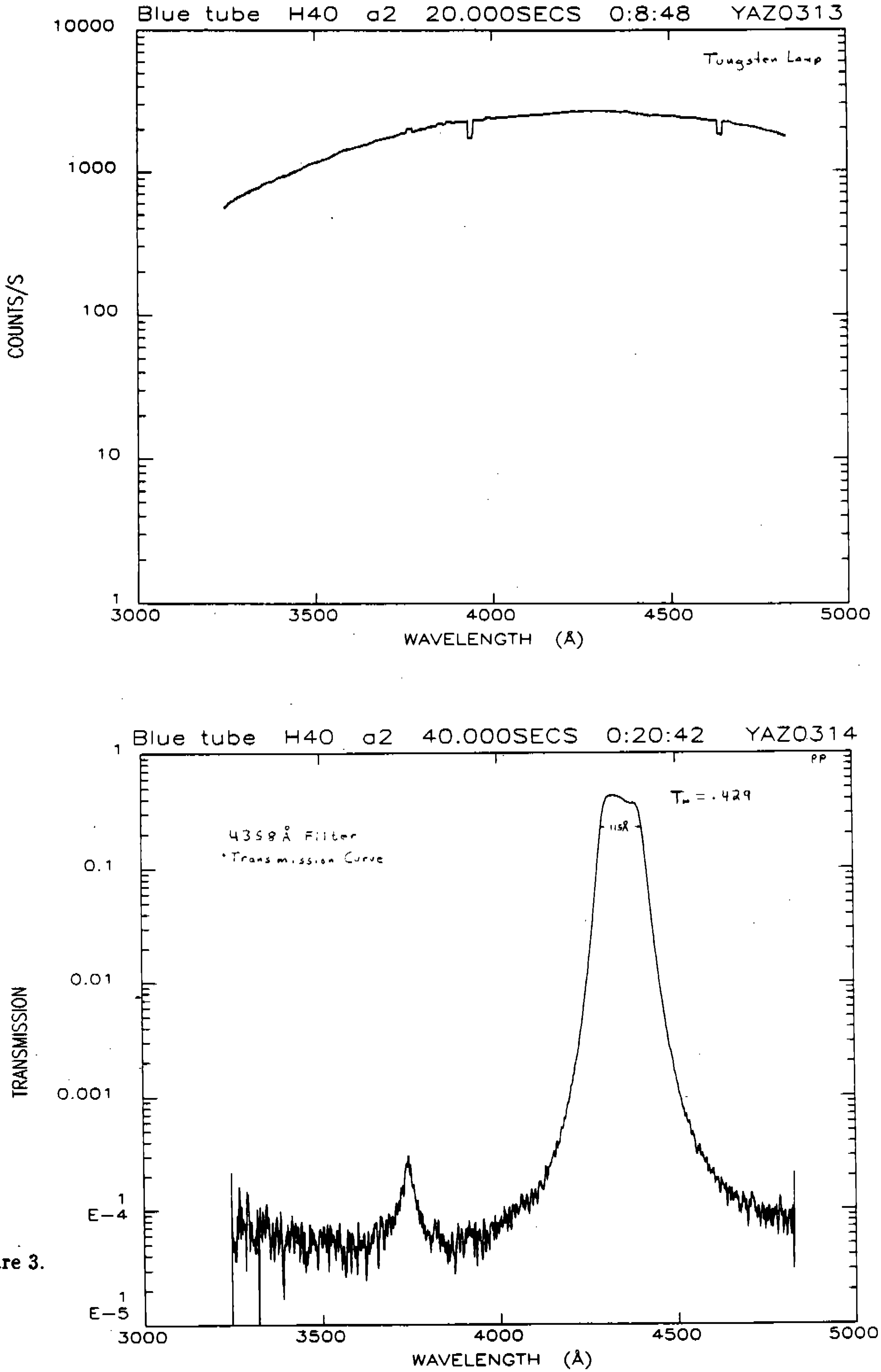

MERCURY SPECTRUM BLUE TUBE A4
H19
H27
H40
H57
COUNTS/S
WAVELENGTH (Å)
1942.3
≈ 2036
≈ 2260.3
2302.09
2480.62
2536.519
≈ 2652.04
2752.78
≈ 2804
2820.0
2893.60
2976.278
≈ 3021.5
3125.663
3131.833
.546
3341.478
3650.146
3654.833
3663.276
4046.561
4077.811
4358.35
4916.036
5460.753
5769.59
5789.66
5790.65

Figure 1.



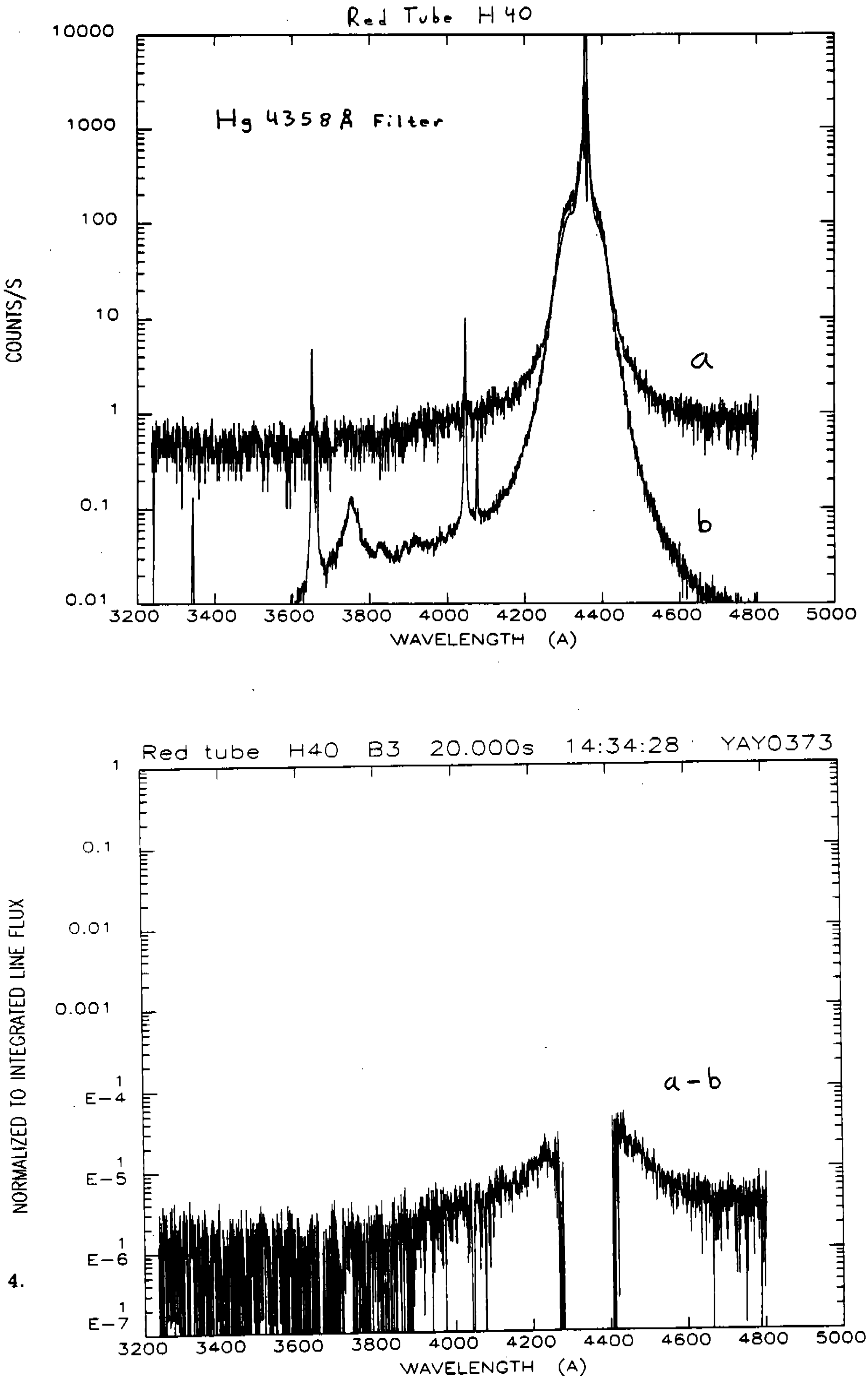
MERCURY SPECTRUM RED TUBE A4
COUNTS/S
10000
1000
100
10
1
H27
H40
2480.62
2536.519
≈ 2652.04
2893.60
2976.278
≈ 3021.5
3125.633
3131.833
3131.546
3341.478
3650.146
3654.833
3663.276
4046.561
4077.811
4358.35
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
WAVELENGTH (Å)
COUNTS/S
10000
1000
100
10
1
H57
H78
4916.036
5460.753
5769.59
5789.66
5790.65
6907.16
6969
7728.49
7944.66
4500
5000
5500
6000
6500
7000
7500
8000
8500
WAVELENGTH (Å)

Figure 2.



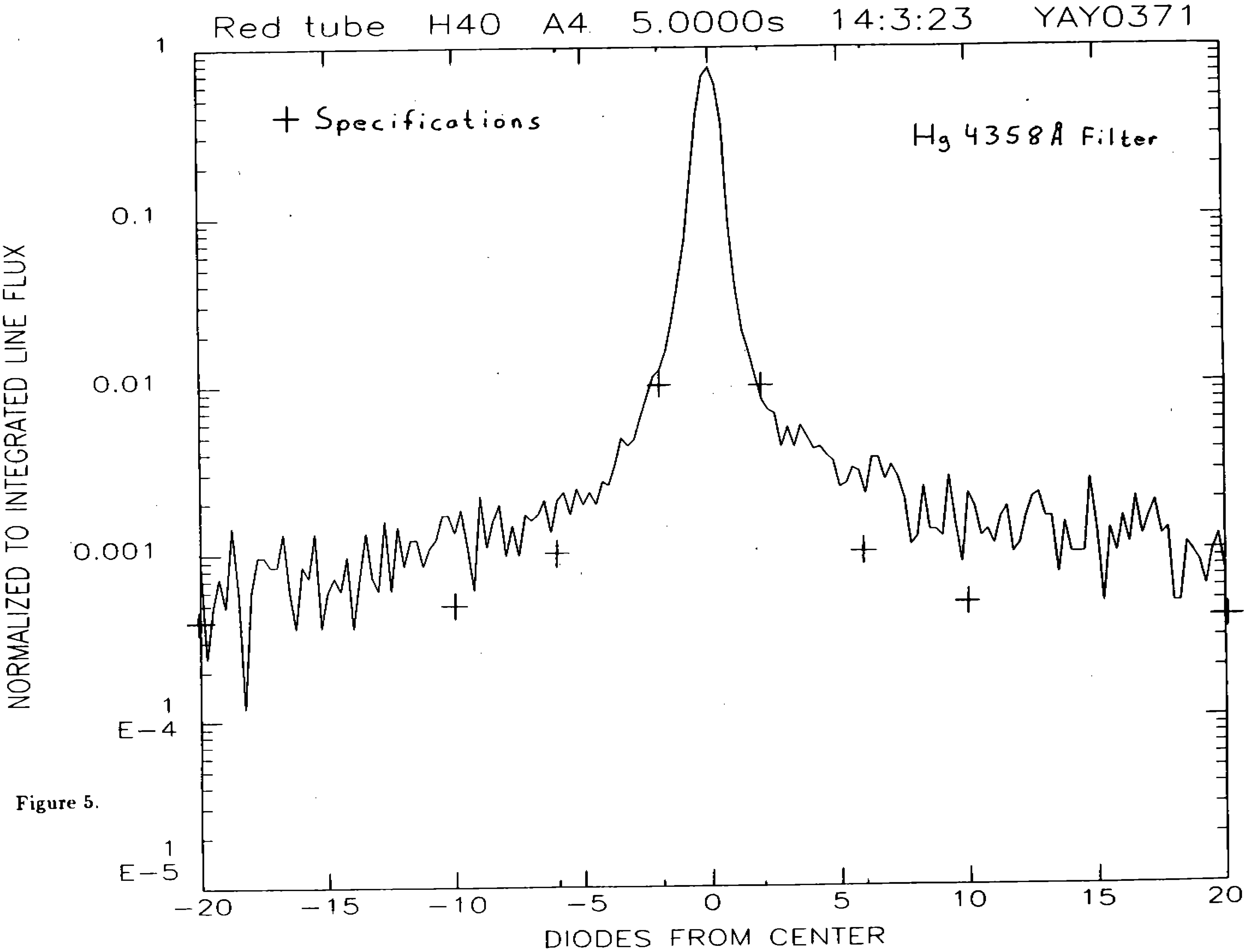
Blue tube H40 a2 20.000SECS 0:8:48 YAZ0313
Tungsten Lamp
COUNTS/S
WAVELENGTH (Å)
Blue tube H40 a2 40.000SECS 0:20:42 YAZ0314
T_m = .429
115Å
4358Å Filter
Transmission Curve
TRANSMISSION
WAVELENGTH (Å)

Figure 3.



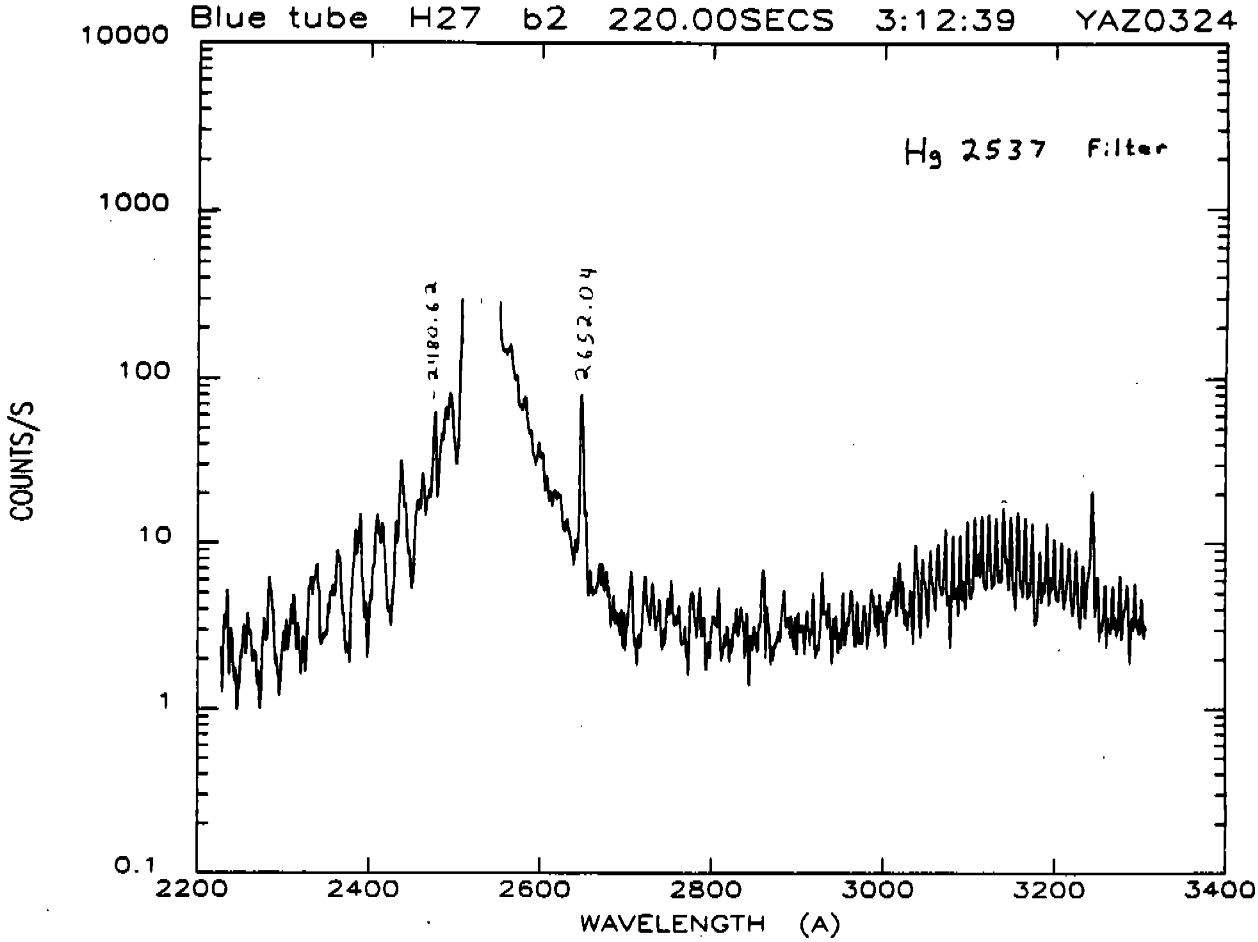
Red Tube H 40
Hg 4358 Å Filter
COUNTS/S
WAVELENGTH (A)
a
b
Red tube H40 B3 20.000s 14:34:28 YAY0373
NORMALIZED TO INTEGRATED LINE FLUX
WAVELENGTH (A)
a - b

Figure 4.



Red tube H40 A4 5.0000s 14:3:23 YAY0371
+ Specifications
Hg 4358Å Filter
1
0.1
0.01
0.001
1 E−4
1 E−5
NORMALIZED TO INTEGRATED LINE FLUX
−20
−15
−10
−5
0
5
10
15
20
DIODES FROM CENTER

Figure 5.


Blue tube H27 b2 220.00SECS 3:12:39 YAZ0324
Hg 2537 Filter
2480.62
2652.04
COUNTS/S
WAVELENGTH (A)

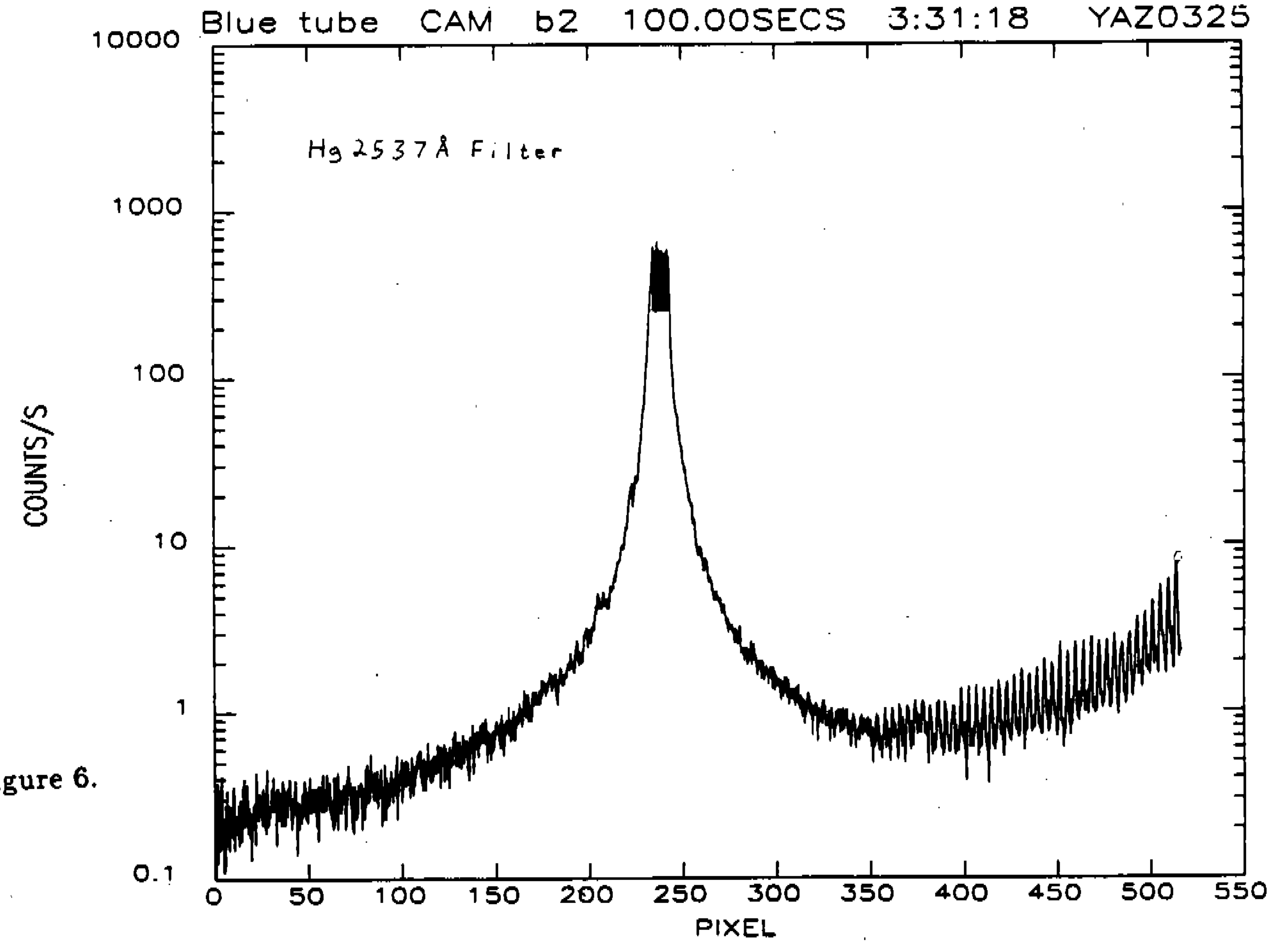

Blue tube CAM b2 100.00SECS 3:31:18 YAZ0325
Hg 2537Å Filter
COUNTS/S
PIXEL

Figure 6.