Science Fiction with IUE. II.

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This is the second in our series of articles on new "discoveries" made with IUE data (see Imhoff and Grady 1985). In each case, the explanations of these "observational results" have to do with some aspect of the instrument, data processing, or calibration, rather than with the characteristics of the sources. We hope you find the article both entertaining and informative.

1. Mg Deficiency in a T Tauri Star

Observational Result: IUE spectra of GM Aurigae, a T Tauri star, show weak Mg II emission after the data has been carefully reduced to compensate for the LWR camera aging and for any contamination by cosmic rays (Fig. 1a). Strong Mg II emission is expected in this star based on the detection of Ca II emission in simultaneous optical spectra.

Explanation: Inspection of the photowrites for the IUE spectra of this star show strong Mg II emission. The lines are sufficiently strong compared to the weak background that the lines are flagged as bright spots (>90 DN above surrounding background) by IUESIPS (Turnrose and Thompson 1984). In the data reduction, if the software ignores or linearly interpolates across all data points which have been flagged by IUESIPS, the Mg II lines can be affected (Fig. 1b). The bright spot flag should be regarded as a warning that the data may be contaminated, but the final judgement must be made by the user.

2. The Primary Ultraviolet Standard η UMa is a Variable Star

Observational Result: Archival IUE low dispersion spectra of the primary ultraviolet standard η UMa, which have been carefully reduced and corrected for camera aging, show that η UMa is a variable star in the vacuum ultraviolet. Since this star has been used as the basis of the IUE absolute sensitivity calibration which will be used for the calibration of the Hubble Space Telescope, this discovery has serious implications for flux calibration of ultraviolet satellites.

Explanation: Virturally all of the archival low dispersion spectra of η UMa were obtained prior to the development of the fast trail techniques reported by Imhoff (1985). At trail rates in excess of 20 arcsec/sec (without the fast trail techniques), the star may graze the aperture, cross it properly, or even miss the aperture totally, thus producing the apparent photometric variation in the archival spectra. This limitation in the trail procedure affects any spectra obtained with large trail rates.

3. B-shell star is a Binary Star

Observational Result: Archival spectra of the bright B-shell star

HD 56014 are found to show variations in the UV continuum fluxes of a factor of 4 (Fig. 2). Since the observations were acquired over many years by a number of observers, no period estimate is possible, but the star should be considered a possible eclipsing binary.

Explanation: The archival spectra of HD 56014 are a mixture of small aperture and large aperture observations. Panek (1982) found that the throughput of the small aperture is 0.5+/-0.25 of the large aperture for a point source. As a result, variations in fluxes of a factor of 4 or so are not uncommon when small and large aperture spectra are intercompared. The IUE fluxes obtained with small aperture spectra are not sufficient to determine whether this object is indeed a binary.

4. LMC O Star Found to be a Variable Star

Observational Result: Previously published SWP low dispersion spectra of an LMC O star are compared with recent acquired spectra. The recent spectra were carefully extracted from the photometrically corrected image using a non-IUESIPS reduction system. The absolute sensitivity data of Bohlin and Holm (1980) were used together with the camera sensitivity change data of Sonneborn (1984) to reduce the extracted spectrum to the form of absolutely calibrated fluxes as a function of wavelength. The recent fluxes are a factor of 3 below the fluxes reported for the original observation.

Explanation: The inverse sensitivity data of Bohlin and Holm (1980) were derived assuming IUESIPS reduction and extraction of the low dispersion spectrum. The IUESIPS extraction for a point source involves summing 9 consecutive lines in the spatially resolved (LBLS) data, with the region to be summed centered on the spectrum. The background is subtracted from the summed spectrum to form the net spectrum. The net spectrum is multiplied by the inverse sensitivity data to produce the net absolutely calibrated spectrum. The non-IUESIPS reduction system which generated the result described above assumed that the gross point source spectrum should be the average of 9 consecutive lines in the LBLS data centered on the spectrum. The effect of using an average gross FN at each wavelength rather than a summed gross FN is to depress the net fluxes by approximately a factor of three. This example illustrates the dependence of the calibration data such as the inverse sensitivity function on the image processing and spectral extraction techniques used to derive them. In general, caution should be used in applying results derived under IUESIPS to non-IUESIPS data reduction schemes.

5. Sharp Red-Shifted C IV Emission in Several Planetary Nebulae

Observational Result: High-dispersion SWP spectra of several faint planetary nebulae reveal weak red-shifted emission lines of C IV. The reality of the features is reinforced by the nearly identical wavelength shifts of the lines from the stronger C IV emission components.

Explanation: There are two weak camera artifacts which fall by sheer coincidence at nearly identical offsets from the two lines of the C IV doublet. These artifacts have been pointed out previously in long exposures by Ayres, Schiffer, and Linsky (1983), Feibelman (1983) and Bohm-Vitense (1983).

6. Evidence for an Outburst in a Peculiar B Star

Observational Result: Archival high dispersion spectra of 17 Lep, a B star subject to outbursts, yield a radial velocity of -50 km/s. A recent LWR spectrum clearly yields a radial velocity of -260 km/s, indicative of a sudden outburst.

Explanation: The later LWR spectrum was processed assuming that it was obtained with the large aperture, but was in fact obtained with the small aperture. The apertures are aligned with the direction of dispersion for high resolution spectra, so this error in processing is translated into a large error in the assigned wavelengths (2 A at 2800 A). The aperture assumed in the processing can be determined by inspecting the processing label in the image label prints.

7. Variability in Mg II Line Profiles for a T Tauri Star

Observational Result: Two early LWR spectra of the T Tauri star RW Aur show changes in the Mg II line profiles at the emission peaks (Figure 3a,b). The peaks changed from rounded, almost flat-topped profiles to sharp emission peaks at higher flux levels. One of the lines is flagged as saturated, but the other is not, in the spectrum with the flat-topped profiles, lending credence to the reality of the shape of the line profile.

Explanation: In data processed prior to 1980, the flux numbers were truncated if the DN of the data exceeded the maximum DN level in the ITF at that location in the image. This truncation has an effect similar to saturation but is <u>not</u> flagged in these early data! In data processed since 1980, such data are extrapolated using the ITF and are flagged as such.

REFERENCES

Ayres, T., Schiffer, F.H., III., and Linsky, J. 1983, Ap. J. 272, 223.

Bohlin, R.C., and Holm, A.V. 1980, NASA IUE Newsletter 10, 37.

Bohm-Vitense, E. 1983, (private communication)

Feibelman, W. 1983, Astron. and Astrophys. 122, 335.

Imhoff, C.L. 1985, NASA IUE Newsletter 27, 1.

Imhoff, C.L. and Grady, C.A. 1985, NASA IUE Newsletter 26, 66.

Panek, R. 1982, NASA IUE Newsletter, 18, 68.

Sonneborn, G. 1984, NASA IUE Newsletter, 24, 67.

Turnrose, B.E., and Thompson, R.W. 1984, IUE Image Processing Information Manual Version 2.0 (new software), CSC/TM-84/6058.

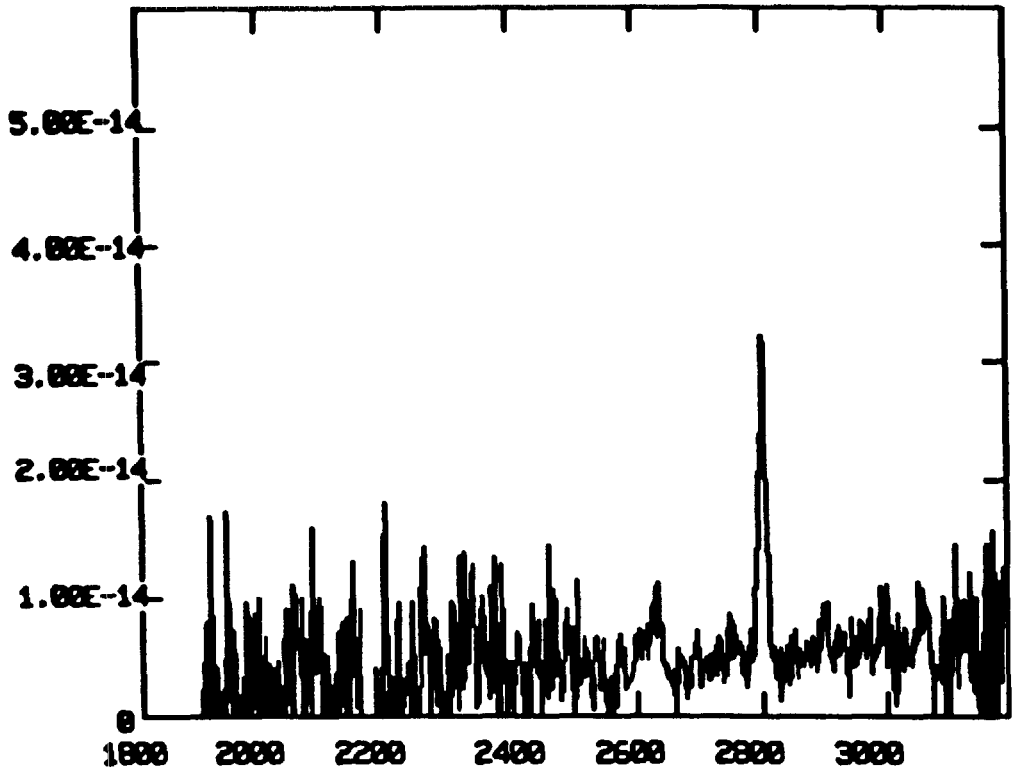

Figure 1 a) IUE low dispersion spectrum of GM Aur (LWR 15016) absolutely calibrated, corrected for camera aging, and with all flagged data (epsilon vector <-200) removed. Mg II fluxes are greatly reduced compard to the fluxes expected from optical data.

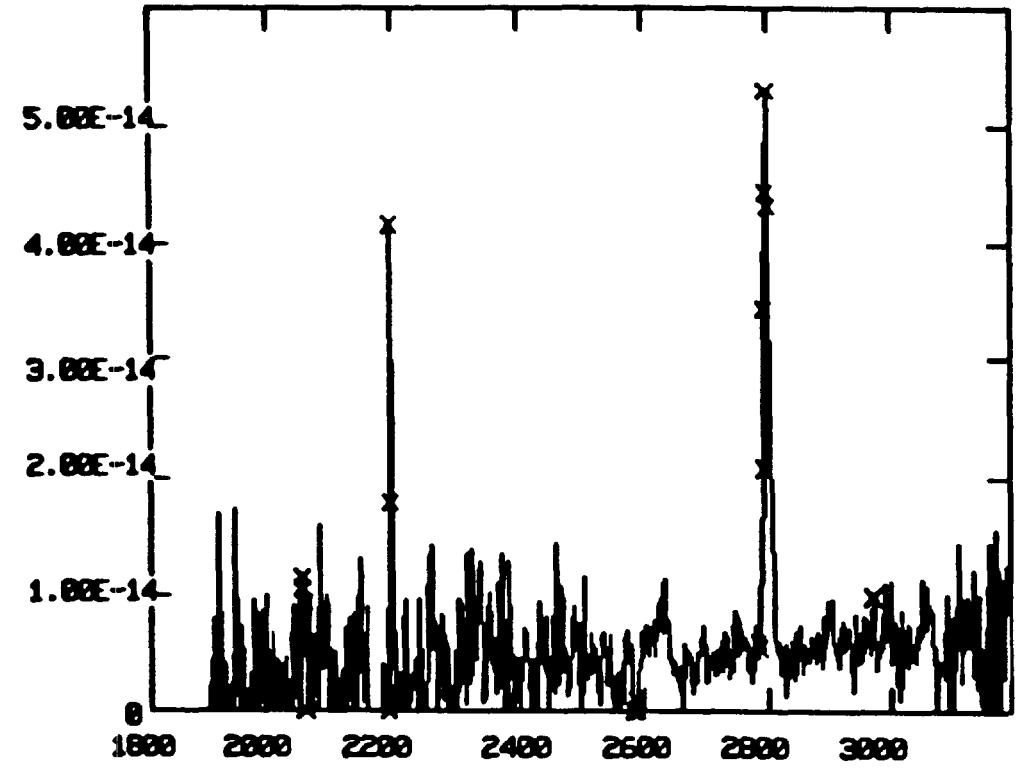

Figure 1b) LWR 15016 showing data points which have been flagged as bright spots and reseaux. The feature at 2190 A is a well-known hot pixel. The feature at 2800 A is Mg II emission flagged with epsilon=-325 (bright spot).

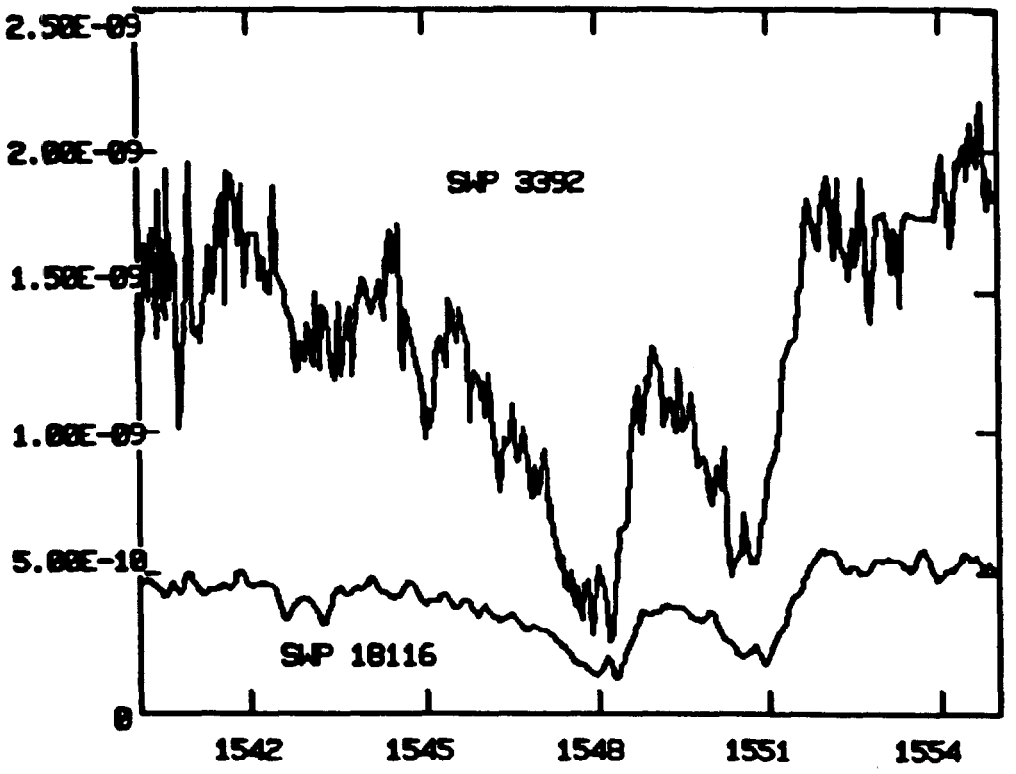

Figure 2: Representative spectra of the B-shell star HD 56014 (B3 III (e)p-sh; Slettebak 1982) showing flux variations in the vicinity of the C IV resonance transitions at 1548, 1551 A.

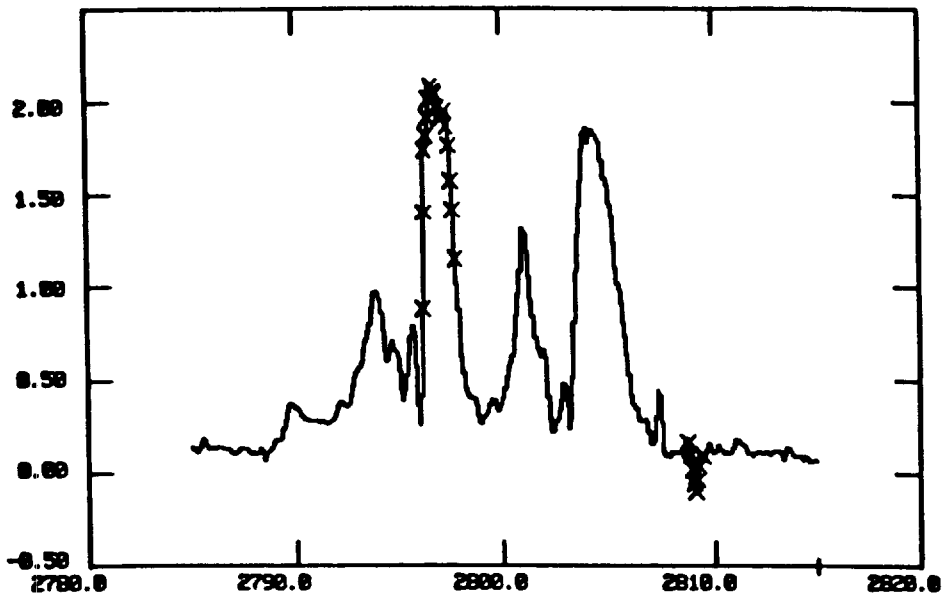

Figure 3a) Early LWR spectrum (LWR 4191) of the T Tauri star RW Aur showing the h line which has been flagged as saturated by IUESIPS and the k line which is unflagged.

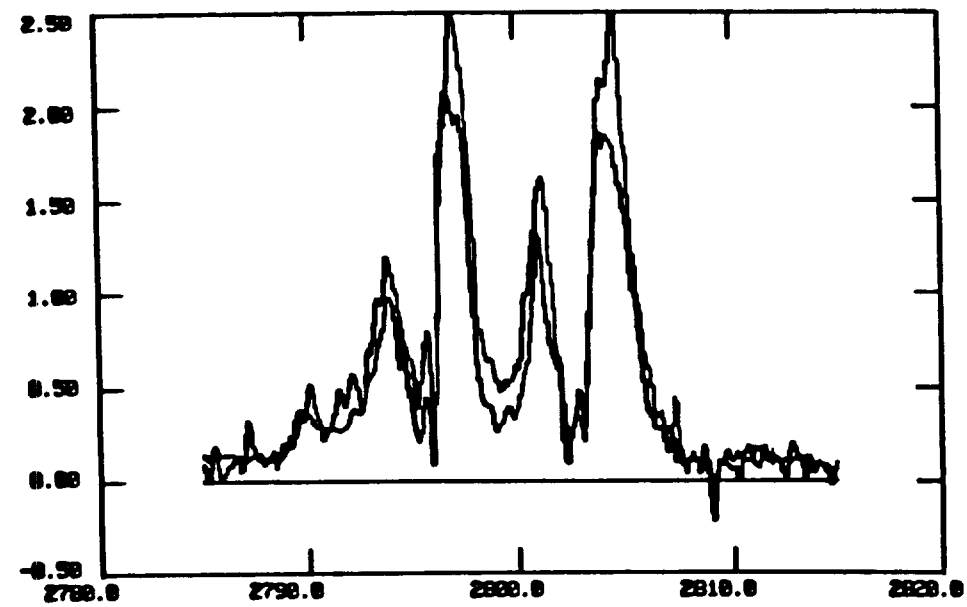

Figure 3b) Comparison of two early LWR spectra of RW Aur (LWR 4191 and LWR 4222) showing the apparent change in profile shape.