

Science Fiction with IUE. I.

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In this series of articles, we explore some new "discoveries" made with IUE data that have instrumental or other origins. In most cases, the "discoveries" described are based on real (and sometimes published) instances. We hope you find the articles enlightening as well as entertaining.

1. A Variable-Redshift QSO

Observational Result: Based on careful measurement of the wavelengths of several emission lines, variations of almost 1% in Z are observed on approximately six-month timescales.

Explanation: The wavelength shifts correspond to errors in the centering of the object in the large aperture. For point sources, centering errors are typically less than 1 arcsec, or about 2 Å in low dispersion. QSOs and galaxies are often acquired by offsetting blindly from a nearby bright star. Thus centering errors of 3 arcsec (6 Å in low dispersion) are not unusual. In this case, the six-month timescale is an artifact of the frequency of observation.

In general, miscentering along the short axis of the large aperture shows up as a wavelength error in low dispersion. If the target is offcenter along the long axis, the spectrum is shifted on the camera perpendicular to the dispersion. If the target is offset sufficiently, not all of the light will go through the aperture. Miscentering can be diagnosed by looking for an offset perpendicular to the dispersion in the line-by-line file, wavelength errors, and by examining the pixel shifts used to fit the wavelength scale in the processing portion of the image header. If the shifts are several pixels, miscentering should be suspected.

2. A New Opacity Source at 2000 Å

Observational Result: By combining archival SWP and LWR spectra, a discontinuity of 30% is seen at about 2000 Å in the sense that the long wavelength fluxes are apparently depressed (Fig. 1).

Explanation: The SWP image used in the study is an old low dispersion spectrum processed with the bad SWP ITF (see Holm 1979; Holm et al. 1982; Turnrose et al. 1984). Errors in fluxes obtained with exposure levels in the 20%-40% range can be as much as 63%. In this case, the gross spectrum was well exposed and apparently unaffected by the error. However, the background spectrum was affected, resulting in an apparent depression of the background at all wavelengths. Thus the net, absolutely calibrated spectrum

is too high compared to the LWR data. Any SWP low dispersion image processed between 22 May 1978 and 7 July 1979 (GSFC) or 14 June 1978 and 7 Aug 1979 (VILSPA) may be affected by the SWP ITF error. A check of the image science header or the IUE Merged Log processing date will indicate if the data is affected (Holm et al. 1982). (All high dispersion SWP images have already been reprocessed). The ITF error can be corrected by reprocessing the image or using an RDAF correction routine.

3. C I Emission in a White Dwarf Spectrum

Observational Result: A weak emission line at about 1657 A is detected on several SWP low dispersion exposures. The repeatability of the features lends credence to its reality.

Explanation: A camera artifact which shows up regularly in long exposures on the SWP is responsible. Other known artifacts lie near the following wavelengths in low dispersion: 1280, 1480, 1570, 1670, 1750, 1870, and 1890 A (Hackney, Hackney, and Kondo, 1984). Similar features are suspected to exist in the LWR, most notably the 2190 A "hot spot".

4. Strong V II Emission in the Spectrum of a T Tauri Star

Observational Result: Strong diffuse emission from 2690 A to 2710 A is detected in an LWR spectrum of a T Tauri star (Fig. 2) having strong Mg II emission.

Explanation: An oblique incidence cosmic ray hit intersects the low dispersion spectrum near 2700 A, which is responsible for essentially all of the emission attributed to the V II. Long exposures with IUE are commonly contaminated by sharp "emission features" due to cosmic ray hits and radioactive decays in the camera phosphor. Cosmic rays that hit obliquely to the camera faceplate produce "comets" visible on the photowrite or in a display of the line-by-line extracted spectra data.

5. Discovery of Hot Companion Associated with a Late-type Main Sequence Star

Observational Result: An absolutely calibrated SWP spectrum of an otherwise normal bright late-type star shows a smooth continuum which rises steeply with decreasing wavelength. The steepness of the companion spectrum and the lack of spectral features suggest that the companion is an extremely hot white dwarf.

Explanation: For F stars and later spectral types, little flux is emitted in the SWP spectral range. The SWP camera is not however blind to flux in the 2000-3200 A range. Grating scatter of 2800 A light can produce an apparently

flat, low-level and featureless continuum, which when absolutely calibrated mimics a hot star flux distribution (Basri, et al. 1985). One signature of scattered light is that the "continuum" continues to wavelengths shortward of 1150 A (where the MgF overcoating of the IUE optics becomes opaque).

6. Discovery of a QSO with a "Square Wave" Continuum

Observational Result: An absolutely calibrated SWP spectrum of a low redshift QSO shows the usual broad emission lines and, at a lower level, numerous flat-topped emission features which rise approximately 10% above the continuum. These features do not correspond to emission lines at the broad-line region redshift.

Explanation: Prior to the US1 shift during which this spectrum was acquired, the SWP camera was overexposed in high dispersion, resulting in a residual phosphorescent spectrum. The residual spectrum is clearly visible in the photowrite and in the line-by-line display of the image, affecting both the gross extraction region and the background extraction regions equally. The typical way of generating the net spectrum smooths the background spectrum heavily, resulting in smearing out of the square wave pattern, which then remains in the net spectrum. Alternate background handling techniques with less smoothing of the background can reduce the contamination of the net low dispersion spectrum.

7. An O Star with the Dramatically Changing Wind Ionization Balance

Observational Result: Reduction of IUE high dispersion archival spectra of an O star shows that the N V 1238, 1242 A and C III 1247 A profiles are spectacularly variable on timescales as short as 35 minutes. In some cases, N V is seen to vanish.

Explanation: Inspection of the photowrites shows that N V was present in all of the spectra. These spectra were obtained early in the IUE mission, at a time when the high dispersion extraction software did not compensate for thermal shifts of the spectral format on the camera faceplate (Grady, 1980). Misregistration due to thermal effects is less of a problem with the current software. Reprocessing of the data using the current software should reduce the spurious variability.

8. Variable Extinction in the Line of Sight to a B Star

Observational Result: LWR spectra of a B star obtained over 1978-1982, when carefully reduced, have shown that the shape and width of the 2200 A feature have changed with time. The nature of the changes suggests that variable

circumstellar extinction by graphite grains may be responsible.

Explanation: Sensitivity monitoring of the LWR camera has shown (Sonneborn, 1984) that the camera sensitivity has changed gradually since launch. The degradation in camera sensitivity is largest near 2300 A (Holm, 1985) and may be misinterpreted as the well-known interstellar 2200 A extinction feature. The algorithm of Holm (1985) may be used to correct LWR spectra for this effect.

References

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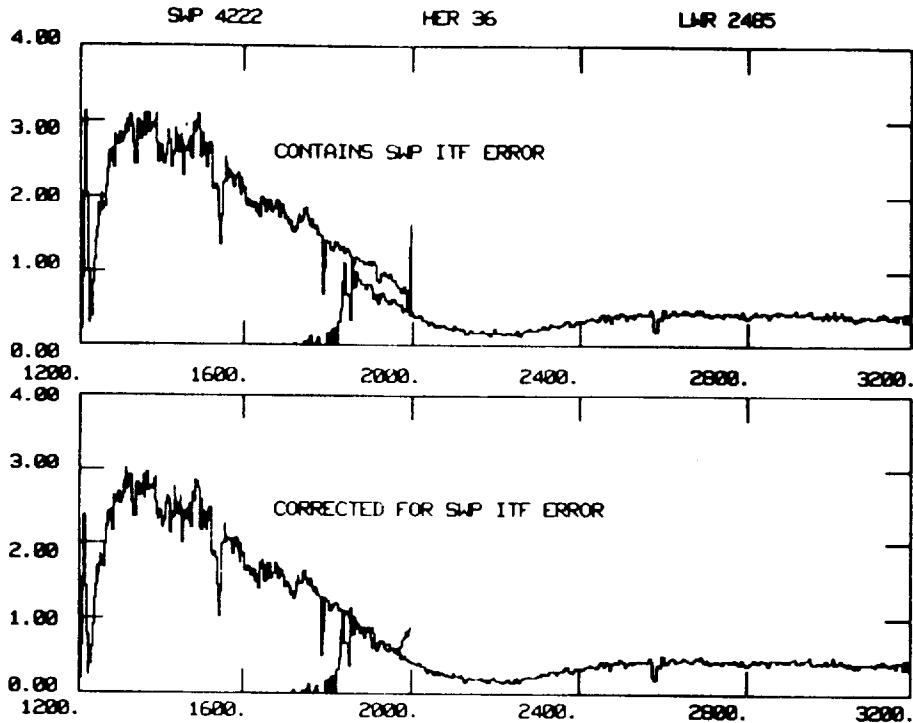


Figure 1: Spectra of Herschel 36 taken from the IUE archives showing the mismatch between the SWP and the LWR spectra resulting from the bad SWP ITF. Upper panel: SWP spectrum as taken from the IUE archives and absolutely calibrated using the May 1980 calibration. Lower Panel: The same spectrum corrected for the bad ITF and otherwise processed identically to the data in the upper panel.

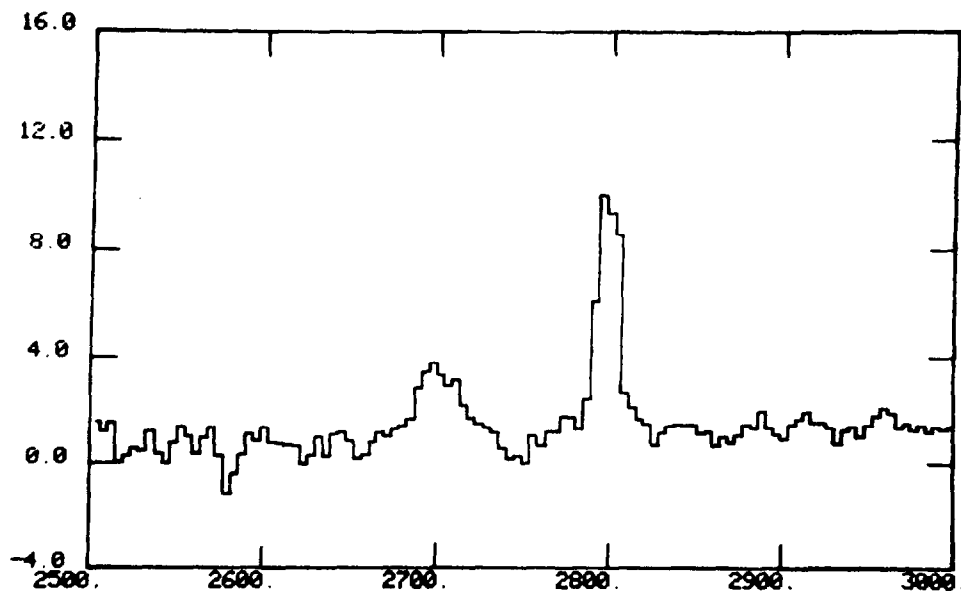


Figure 2: Spectrum of RW Aur (LWR 4182) showing an apparent V II emission feature at 2700 A which is in fact due to the broad "comet tail" of a cosmic ray hit. The feature at 2800 A is Mg II which is normally seen in this object.