ABOUT THE PHOTOMETRIC CALIBRATION OF IUE HIGH RESOLUTION SPECTRA: QUANTIFICATION OF THE ORDER OVERLAP FOR THE SWP CAMERA

Luciana Bianchi

Astronomical Observatory of Turin

Ralph Bohlin

Space Telescope Science Institute

ABSTRACT. In order to quantify the errors in the IUE line profiles caused by the order overlap, we have compared line depths in IUE and Copernicus spectra. The excess line depth in IUE spectra suggests that the amount of order overlap is about 32% at 1150Å and decreases to zero at about 1400Å, for spectra extracted with the recent version of IUESISPS (the IUE standard extraction software). The transfer of a spectral feature from one order to the next is below the 5% level.

Based on these results, a correction technique is described.

1. INTRODUCTION

A longstanding problem with the IUE high resolution data is the determination of the true background level in the region of the spectral format where the orders are closely spaced. Order overlap is primarily an artificially-raised background level caused by the overlapping wings of the order profile in the higher echelle orders. A secondary effect is the transfer of a spectral feature from one order to the neighboring ones, due to the long range term of the point spread function (PSF).

An earlier evaluation of the problem and a correction technique is given by Bianchi (1980). In order to quantify the amount of order overlap we have compared line depths in IUE spectra to line depths observed by Copernicus. The excess line depth, i.e., the order overlap, in IUE spectra can be expressed as a percent of the local net continuum level. The net is the most appropriate quantity to scale the order overlap, because gross and background are affected by the radiation level and the camera null drift.

D. S. Hayes et al. (eds.), Calibration of Fundamental Stellar Quantities, 443–446.

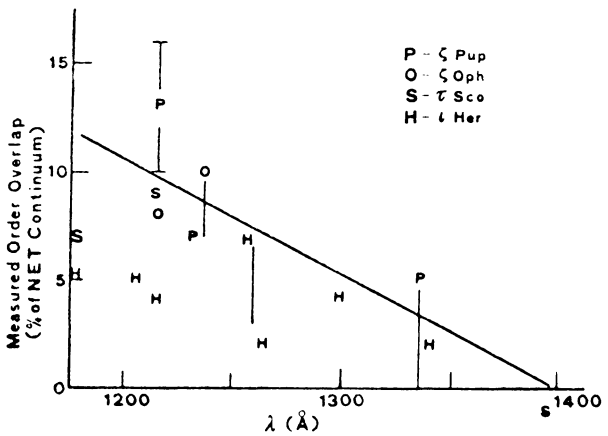

Fig.1. The measured order overlap (in % of the net flux). Typical error bar is indicated for one point.

2. COMPARISON OF IUE AND COPERNICUS SPECTRA

The IUE resolution is 0.1Å, intermediate between the Copernicus U1 and U2 spectra (resolution 0.05 and 0.2Å respectively); therefore we have chosen absorption lines broad enough so that the U1 and U2 line depths agree within 5%. We further restricted the choice to lines with central depth between 0 and 35% of the continuum.

We analyzed spectra of stars for which complete U1 and U2 scans were available. All the IUE spectra were reprocessed with the recent version of the standard software (Bohlin and Tunrose 1982). The details of the data and the lines used are given in Bianchi and Bohlin (1984). The measured order overlap is shown in Fig. 1. The amount of order overlap is found to be about 32% of the net spectrum at 1150Å, decreasing to zero at about 1400Å. In the spectra extracted with the older software, the order overlap is worse by 10%. However, larger errors could be present in these spectra, since the spectral registration was less accurate and less stable (see e.g., Thompson and Bohlin 1982).

3. CORRECTION TECHNIQUES

For spectra extracted with the old software a correction technique is recommended such as that of Bianchi (1980). For spectra extracted with the recent software, in which the background and the spectral registration are more stable, a simple correction routine based on the results of this paper is outlined here. It should give results accurate to about 5%, for large aperture spectra (point sources, in focus). Let's consider only the order m itself and the two neighboring orders m-1 and m+1. The corrected net N_o can be expressed in terms of the net n_o on the software tapes as:

$$N_o = n_o + \Delta B_o + (\Delta B_- + \Delta B_+)/2 - \Delta N_- - \Delta N_+ \qquad (1)$$

https://doi.org/10.1017/S0074180900079183 Published online by Cambridge University Press

The subscripts -, o and + refer to the orders m-1, m and m+1, respectively. The corrections ΔB are normalized to the extraction slit height and are due to the fact that the extraction background is too high. The corrections ΔN are the excess contribution to the gross from the wings of the adjacent orders. For the case of a deep line as measured by the correction C in Fig. 1, $\Delta B_o=0$. On the average, the nearby orders have approximately the same net continua n. With these assumptions and some knowledge of the order profile shape, a solution can be obtained. The precise PSF for IUE is not known, but Bianchi (1980) has shown that the core of the profile is gaussian with a longer range component in the wings. These wings produce the elevated background in the short wavelength orders and probably drop off as r^{-2} (r=distance from the peak of the order). Thus, if b is the background contribution due to one order, then this order contributes as an increase of b/4 to the neighboring net and as b/9 to the background on the other side of order m. In summary:

$$\Delta B_o=0,\ \Delta B_-=\Delta B_+=b+b/9,\ \Delta N_-=\Delta N_+=b/4,\ n_-=n_+=n.$$

Eq. 1 becomes:

$$N_o-n_o=b+b/9 - b/4 - b/4 = 11b/18 \qquad (2)$$

Since the difference N_o-n_o is just what has been measured (Fig. 1), if C is the fractional correction in terms of n, then b=18Cn/11. The general solution is therefore:

$$N_o=n_o+1.636C(n_o)+0.5C(n_-)+0.5C(n_+) \qquad (3)$$

where $( )$ indicates the appropriately smoothed net spectrum. The appropriate smoothing is 31 points filter done twice, just the same as the background smoothing for the new software, since the correction is essentially for errors in the smooth background used to compute the net on the tape. In the case where the three continua are all equal, then $(N_o-n_o)/(n_o)=2.636C$ (eq. 3), which is used to estimate the maximum order overlap of 32% when C=0.12 at 1150Å.

A FORTRAN program to implement this correction is given in Bianchi and Bohlin (1984). In Fig. 2 we show an example of a corrected IUE line profile (SiIII λ1206.5Å in zeta Pup) compared to the line profile from Copernicus.

REFERENCES

Bianchi, L. 1980, in IUE Data Reduction, ed. W. Weiss et al., (Vienna: Austrian Solar and Space Agency), p.161.
Bianchi, L. and Bohlin, R. 1984, Astron. Astrophys., in press.
Bohlin, R. and Tunrose, B. 1982, NASA IUE newsletter N.18, p.29 and ESA IUE newsletter N.13, p.14.
Thompson, R. and Bohlin, R. 1982, NASA IUE newsletter N.18, p.45.

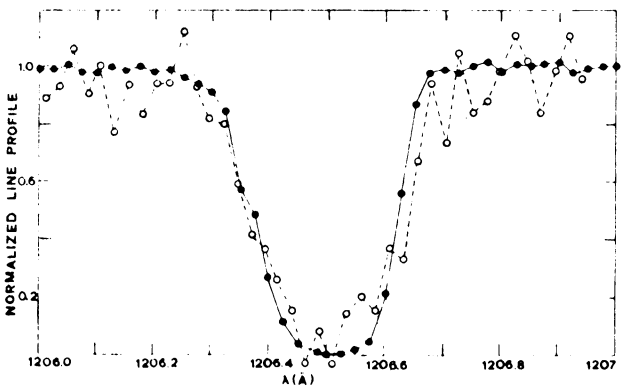

Fig.2. An IUE line profile corrected by our technique (open circles) and the U1 scan from Copernicus (filled circles) with 0.05Å resolution.

DISCUSSION

BIANCHI: I want to point out that an error of 32% in the continuum is an error of 32% in the equivalent width.

https://doi.org/10.1017/S0074180900079183 Published online by Cambridge University Press