IUE DATA REDUCTION

V. WAVELENGTH ASSIGNMENTS FOR LARGE APERTURE SPECTRA

In both the low and high dispersion modes, IUE wavelength scales are established by Pt-Ne spectra obtained through the small entrance aperture. For small-aperture astronomical target spectra, the wavelength scales apply directly as measured; for large aperture spectra, the small-aperture scales are transplanted to a "standard" reference location within the large aperture by means of offsets in pixels, which are applied to the constant or zero-point terms of the dispersion relations. If \( a_0 \) and \( b_0 \) are the zero-point terms for the small-aperture sample and line dispersion equations, the corresponding zero points for the large aperture are \( a_0 + \Delta s \) and \( b_0 + \Delta L \). \( \Delta s \) and \( \Delta L \) are the offsets defining the pixel displacements from the small aperture to the large aperture in the sample and line directions, respectively. The purpose of this memorandum is to describe recent changes in the "standard" values of \( \Delta s \) and \( \Delta L \) and to quantify changes in the derived large aperture wavelength scales resulting from the new offsets.

Previously, the \( \Delta s \) and \( \Delta L \) offsets to the "center" of the large aperture were values which had been measured on the EDS display screen for each camera, in geometrically corrected units, to an accuracy of about one pixel. As a result of several recent analyses of the entrance-aperture geometry and the placement of astronomical objects within the large aperture, however, a more refined procedure for defining \( \Delta s \) and \( \Delta L \) has been developed. A. Holm has performed aperture-mapping for both the LWR and SWP cameras and measured, for both cameras, a small displacement between the physical center of the large aperture and the point at which the telescope operations procedures normally placed objects in the large aperture prior to August 1, 1979. On 1 August 1979 a change in telescope operations procedures was made to place objects nearer to the physical center of the large aperture; this is further discussed later in the text). Furthermore, more accurate measurements of the orientation of the physical centers of the large and small apertures have been made. Finally, the separation of the small aperture and the old object-placement point within the large aperture has been accurately determined by examination of the dispersion constants resulting
from the automatic-shift software (DSPCON) on images where both large and small aperture spectra exist. The results of all these studies have been combined, generating improved large-aperture offset values for both the physical centers and the old object-placement points. The new offsets are given in Table 1, along with the older, less accurate, offset values. The new offsets are estimated to be accurate to several tenths of a pixel unit.

Table 1. Separations and Line and Sample Offsets to the Large Aperture for LWR and SWP Cameras.

\[ R = \left( (\Delta s)^2 + (\Delta L)^2 \right)^{\frac{1}{2}}. \text{ All in pixel units.} \]

<table>
<thead>
<tr>
<th></th>
<th>SWP</th>
<th>LWR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\Delta L)</td>
<td>(\Delta S)</td>
</tr>
<tr>
<td><strong>OLD OFFSETS</strong></td>
<td>-20.0</td>
<td>-17.0</td>
</tr>
<tr>
<td><strong>PHYSICAL CENTER</strong></td>
<td>-19.7</td>
<td>-17.4</td>
</tr>
<tr>
<td><strong>OBJECT PLACEMENT (Prior to 1 August 1979)</strong></td>
<td>-19.9</td>
<td>-17.1</td>
</tr>
</tbody>
</table>

Beginning 8 July 1979, the \(\Delta S\) and \(\Delta L\) for the "old object placement" points in Table 1 were the offsets used in the data reduction programs to provide the transplantation of wavelength scales for large aperture spectra. Because these offsets differ from the old values, particularly in LWR, there is implicit in all-large aperture spectra extracted prior to 8 July 1979 a systematic wavelength error. The magnitude and sign of the error depend on the camera and dispersion mode in a manner which can be visualized in Figures 1 and 2. These Figures show the relative locations of the
points defined by the three sets of offsets listed in Table 1, along with an overlay defining the dispersion directions for a) low dispersion, and b) high dispersion, echelle order m=100. In these Figures, the wavelength scales shown have been generated from typical dispersion relations. The scales used are given in Table 2. The high dispersion values are approximations obtained using dispersion relations including only terms linear in \( \lambda \) and the product \( m \lambda \). (Such approximate dispersion relations are used as the "preliminary solution" or starting point in the standard dispersion-relation regression analysis, which, in its final form, allows higher-order terms quadratic in \( m \) or \( \lambda \). The approximate relations shown here are generally accurate to the subpixel level and have the simplifying advantage that the \( \lambda \)/pixel values scale inversely with echelle order number \( m \).)

**Table 2.** Approximate Dispersion Scales (\( \lambda \)/pixel along dispersion direction)

<table>
<thead>
<tr>
<th>CAMERA</th>
<th>DISPERSION</th>
<th>( \lambda )/pixel</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWP</td>
<td>Low</td>
<td>1.667</td>
</tr>
<tr>
<td></td>
<td>High (m=100)</td>
<td>0.035</td>
</tr>
<tr>
<td>LWR</td>
<td>Low</td>
<td>2.649</td>
</tr>
<tr>
<td></td>
<td>High (m=100)</td>
<td>0.056</td>
</tr>
</tbody>
</table>

From Figure 1 it is evident that the old offsets caused a small zero-point error in the low dispersion large-aperture wavelength scale for SWP, but essentially no error in high dispersion. Figure 2 indicates that both high and low dispersion scales were affected in LWR. Table 3 lists the nominal
wavelength errors caused by using the old offsets instead of the correct offsets to the actual object placement points. The errors $\Delta \lambda$ are defined in the sense

$$\lambda_{\text{old}} = \lambda_{\text{correct}} + \Delta \lambda.$$  

Several points are to be noted regarding the current analysis. For point sources, the relevant fiducial for the large aperture is the actual object placement point; for aperture-filling extended sources the more relevant fiducial is the physical center of the aperture. The standard wavelength scales have, since 8 July 1979, been referred to the object placement points. On 1 August 1979, the telescope operations procedures were modified

**Table 3. Nominal Large-Aperture Wavelength Errors Caused by Inaccurate Offsets Prior to 8 July, 1979**

<table>
<thead>
<tr>
<th>CAMERA</th>
<th>DISPERSION</th>
<th>$\Delta \lambda$ ($\AA$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWP</td>
<td>Low</td>
<td>+0.23</td>
</tr>
<tr>
<td></td>
<td>High (m=100)*</td>
<td>+0.0006</td>
</tr>
<tr>
<td>LWR</td>
<td>Low</td>
<td>-1.76</td>
</tr>
<tr>
<td></td>
<td>High (m=100)*</td>
<td>0.090</td>
</tr>
</tbody>
</table>

* For other orders, $\Delta \lambda$ is approximately 100/m times the tabular value, where $m$ = order number.

to make the object placement points coincide with the physical centers of the large apertures, and the offsets used in the data reduction for
all images acquired as of that date have been changed to the "physical center" values listed in Table 1. In this way, the assigned large-aperture wavelength scales will be correct for both point and diffuse sources.

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R. Bohlin  
A. Holm  
C. Marvel
Figure 1.

SWP OFFSETS FROM SMALL APERTURE (SWSA)

+ PHYSICAL CENTER OF SWLA

● FORMER OBJECT PLACEMENT IN SWLA (PRIOR TO 3 AUG. 77)

○ OLD STANDARD OFFSET FOR SWLA

DISPERSION CONSTANT

Sample direction offsets from small aperture (SWSA)

-18.2 -18.0 -17.8 -17.6 -17.4 -17.2 -17.0 -16.8 -16.6 -16.4

0.01 Å

0 Å

10 Å
FIGURE 2.

LWR OFFSETS FROM SMALL APERTURE (LWSA)

- PHYSICAL CENTER OF LWSA
- FORMER OBJECT PLACEMENT IN LWSA (PRIOR TO 5 AUG. 79)
- OLD STANDARD OFFSET FOR LWSA

DISSPERSION COEFFICIENTS

- 1.0 Å

- 0.01 Å

SAMPLE DIRECTION OFFSETS FROM SMALL APERTURE (LWSA)

- 19.4 - 19.2 - 19.0 - 18.8 - 18.6 - 18.4 - 18.2 - 18.0 - 17.8 - 17.6 - 17.4