IUE DATA REDUCTION

XXXI. Improved LWP Large-Aperture Offset

With the information available from the latest set of mean LWP dispersion constants (see IUE Data Reduction XXX), it is possible to calculate a refined value for the offset from the long wavelength small aperture (LWSA) to the long wavelength large aperture (LWLA) as seen in the long wavelength prime (LWP) camera. This offset value is needed to transplant the fundamental LWP small-aperture dispersion relations to the large aperture. For the short wavelength prime (SWP) and long wavelength redundant (LWR) cameras, small-to-large-aperture offsets were presented in IUE Data Reduction Memo V (NASA IUE Newsletter No. 6). The preliminary LWP offsets in use prior to the effective date of this memo represented a mirror-reflection of the LWR offsets.

If Z is the distance along the low-resolution order in pixels, the low resolution dispersion dλ/dZ is defined by

$$\frac{d\lambda}{dZ} = \frac{1}{\frac{dZ}{d\lambda}} = \frac{1}{\sqrt{\left(\frac{ds}{d\lambda}\right)^2 + \left(\frac{d\ell}{d\lambda}\right)^2}} = \frac{1}{\sqrt{a_2^2 + b_2^2}} = \frac{1}{.3779060}$$

$$= 2.646 \pm 0.002 \text{ Å/pixel}$$

where $a_2 = -0.286471340$ and $b_2 = 0.246469336$ are the scale terms of the mean dispersion relations.

For comparison, in the long wavelength redundant (LWR) camera the dispersion scale is dλ/dZ = 2.652 ± 0.002 Å/pixel. This implies that in the spectral image plane, 1 LWP pixel = 0.9977 ± 0.001* LWR pixel. Hence the separation of the LWSA and the LWLA, taken to be R = 26.9 pixels (with an estimated uncertainty of about 0.1 pixels) in LWR, may with little error be taken to be 26.9 pixels in LWP as well.

*Formal error if the LWR and LWP errors quoted above are considered to be independent. If they are non-independent, this formal error estimate increases to ±0.004 pixels.

Together with the knowledge of the angle which the low dispersion spectrum makes with the image scan lines, this information is used to calculate the offset to the LWLA from the LWSA, as follows. The angle Θ between the order and an image line is defined by

$$\Theta = \arctan\left(\frac{d\ell}{ds}\right) = \arctan\left(\frac{b_2}{a_2}\right) = -40.^\circ 7.$$

Since the angle ω_s between the dispersion line and the line joining the LWSA and the LWLA is known from LWR studies to be $83^\circ \pm 0^\circ\!.5$, the angle α between an image line and the LWSA-LWLA connector is $42^\circ\!.3 \pm 0^\circ\!.5$; see Figure 1. Hence the line and sample components of the offset to the LWLA from the LWSA are

$$\Delta L = R \sin (42^\circ\!.3 \pm 0^\circ\!.5) = +18.1 \pm 0.2 \text{ pixels}$$

$$\Delta S = R \cos (42^\circ\!.3 \pm 0^\circ\!.5) = +19.9 \pm 0.2 \text{ pixels}$$

Effective September 21, 1982 these offsets have been used in defining the large-aperture dispersion relations for LWP, replacing the previously-used LWR mirror-reflection values of $\Delta L = 19.4$ and $\Delta S = 18.6$. Assuming that the new offsets correctly indicate the location at which objects are placed in the large aperture, Figure 2 shows that the use of the former offsets had introduced a wavelength error of -4.8Å in low dispersion and a velocity error of -1.0 kms^{-1} (i.e., -0.008Å in order 100) in high dispersion.

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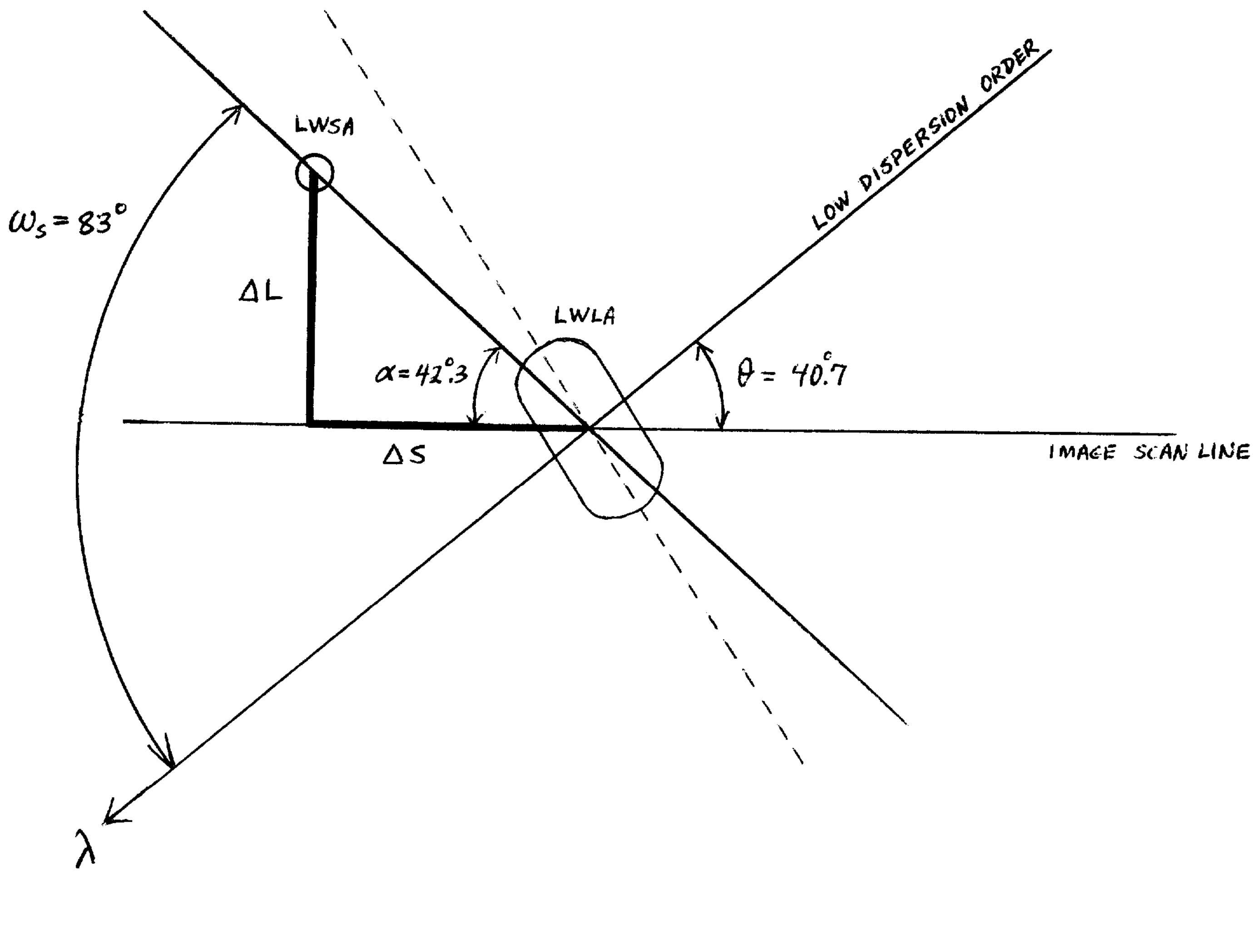

Figure 1. LWP Aperture Geometry.

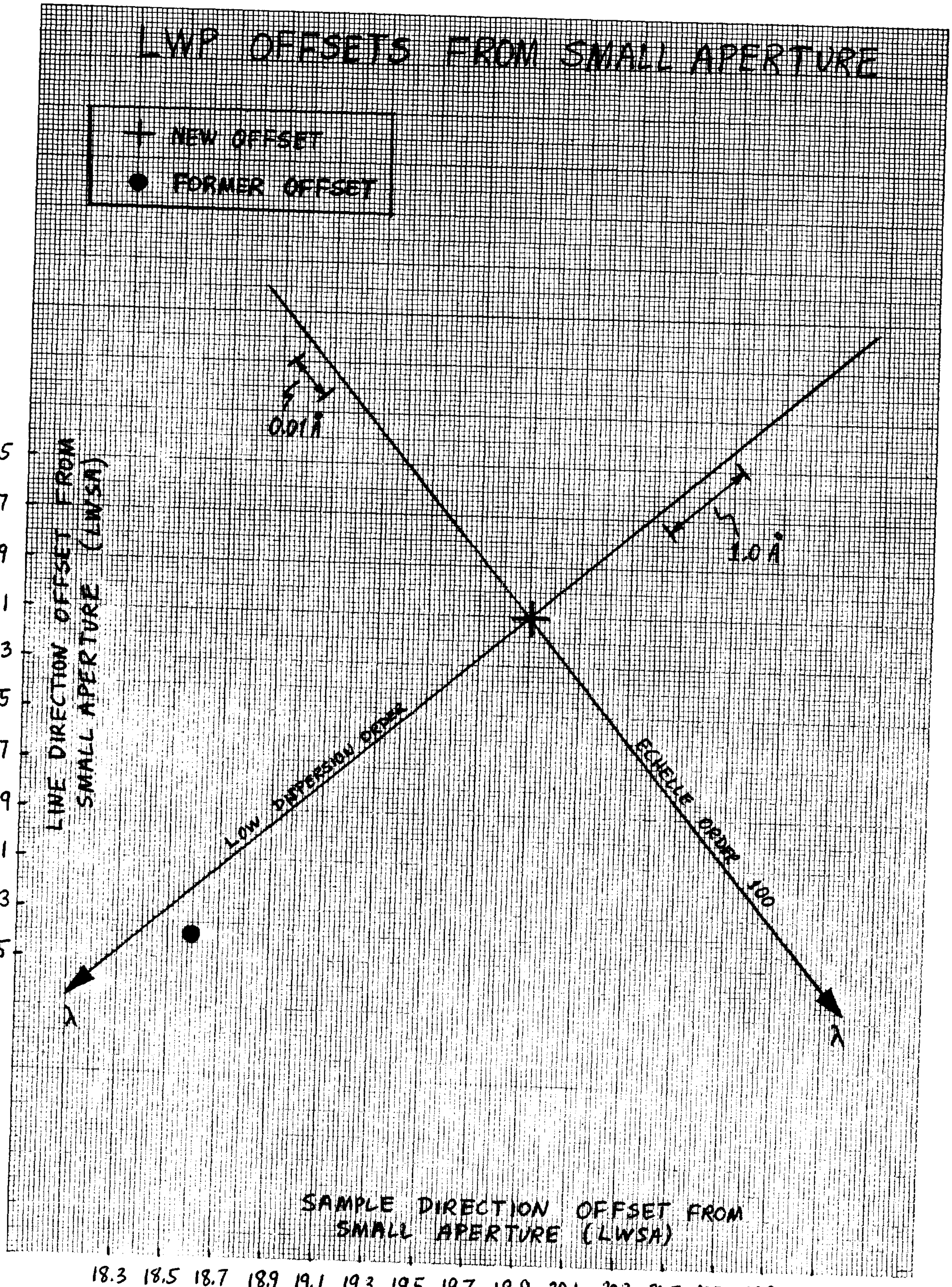
LWP OFFSETS FROM SMALL APERTURE
NEW OFFSET
FORMER OFFSET
0.01 Å
1.0 Å
LOW DISPERSION ORDER
ECHELLE ORDER 100
λ
λ
LINE DIRECTION OFFSET FROM SMALL APERTURE (LWSA)
17.5
17.7
17.9
18.1
18.3
18.5
18.7
18.9
19.1
19.3
19.5
SAMPLE DIRECTION OFFSET FROM SMALL APERTURE (LWSA)
18.3 18.5 18.7 18.9 19.1 19.3 19.5 19.7 19.9 20.1 20.3 20.5 20.7 20.9 21.1

Figure 2