IUE Calibration Progress Report -
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This report summarizes the highlights of recent calibration work.

I. Low-Dispersion Absolute Calibration

A preliminary version of the new SWP absolute calibration for low-dispersion spectra has been derived. The new calibration is based on about 200 standard star spectra obtained during 1984-1985 and processed with the new SWP ITF (ITF3). Preliminary inverse sensitivity curves were derived for large-aperture point-source, trailed, and small-aperture spectra. The inverse sensitivity curves show small-scale structure; further work is needed to determine if smoothing the curves will improve the quality of the calibration. In addition, comparisons need to be made for standard star spectra with both the old and new calibrations to quantify the differences between the old and new calibrations, and to identify the subset of SWP data that would benefit from the new calibration.

II. High-Dispersion Ripple Correction:

A revised SWP ripple correction has been derived from high-dispersion spectra obtained between March 1982 through January 1988 (Grady and Garhart, 1989). The SWP ripple correction shows no significant change over six years for spectra which have been similarly exposed and which were obtained at the same camera head temperature (THDA). The ripple correction is weakly sensitive to THDA, with increased camera THDA resulting in systematically increased K parameters. The revised ripple correction was based upon images with an avetage THDA of 10.5 C, which is more typical of current SWP camera temperatures. The revised ripple correction will be implemented in IUESIPS in the near future.

In the course of a study to derive new LWP and LWR ripple corrections, two problems with the extraction and background handling were discovered. These problems are responsible for significant deviations from the sinc-squared dependence with wavelength predicted for an echelle grating. First, the currently implemented background filters introduce spurious spectral features into the data. Alternate background smoothing techniques have been investigated (see section III, below). Second, the extraction slit for both the gross and interorder spectra are apparently misplaced at the short end of each order. This misplacement of the extraction slit results in a depression of the net flux by about 20-50% at the short wavelength end of each order. The exact source of the misregistration is not completely understood, but is thought to be due to a combination of factors: inaccuracy in the geometric correction, inaccuracy in the wavelength calibration due to a relative lack of platinum lines used in the wavelength calibration in this region of the camera, and the automatic registration method. Derivation of a new LWP ripple correction has temporarily been put on hold pending the solution of the extraction problem.

III. High-Dispersion Inter-Order Background Smoothing

Analysis of LWP high-dispersion spectra showed that the inter-order background smoothing technique currently implemented in IUESIPS and at the RDAFs could introduce spurious absorption or emission features into net spectra, greatly complicating the interpretation of IUE data. The effect is most pronounced for portions of spectral images where the gross spectrum is a few times the background level, and is also present in the LWR, and to a lesser extent the SWP. As an alternative to the current IUESIPS median and mean filters, the technique of fitting the background with low order polynomials has been investigated. A version of such an algorithm, based on LFIT from Numerical Recipes (Press, et al. 1986), and using Chebyshev polynomials as basis functions, has been tested on a number of high-and low- dispersion spectra for all three cameras. Using the first 5-6 Chebyshev polynomials in the fit results in improved smoothness in the inter-order background, and elimination of the spectral artifacts. The algorithm will be recommended for implementation in IUESIPS, and will also be made available to GSFC RDAF users. A detailed report on the background smoothing technique is given in this newsletter.

IV. Wavelength Calibration

The IUE Project has begun work on producing new line libraries for wavelength calibration, which will include wavelengths for UV lines not in the present libraries and updated wavelengths for existing lines. The published wavelengths by J. Reader, et al., of the National Institute of Standards and Technology will be used as the reference. It is possible that use of the more extensive library of comparison lines, especially one with a better representation of lines in the short wavelength ends of the orders, will help to reduce the high-dispersion LWP and LWR extraction problems. It should be noted that the revision of the line library could involve the reprocessing of approximately 1000 wavelength calibration images and re-deriving the time and temperature correlations for the cameras.

V. Camera Artifacts

Fifty-one SWP, 47 LWR and 29 LWP sky background images were used to look for artifacts in low-dispersion spectra; a preliminary report on SWP artifacts was given by Bruegman and Crenshaw (1989). It is believed that the artifacts in the low-dispersion spectra have at least three origins, with different characteristics for each. There appears to be a large-scale pattern over hundreds of angstroms which has grown with time, and may be related to the sensitivity degradation of the cameras. There is also a low-level pattern which resembles spectral features and is present in both short and long exposures. The third type of artifact mimics emission features and is present in long exposures (on the order of hours). This type of artifact may be due to "warm pixels" which increase slowly in DN relative to their neighbors during the exposure. Analysis of sky background, TFLOOD, null, and standard-star images is in progress to gain a better understanding of the LWP, SWP, and LWR artifacts.

VI. Low-Dispersion Sensitivity Monitoring

The low-dispersion sensitivity monitoring analysis for the LWP, LWR, and SWP cameras has been updated to March 1989. The SWP degradation rates are similar to values previously reported. The rate of the LWR sensitivity degradation appears to have slowed, which is probably tied to the fact that the LWR is the backup long-wavelength camera and is generally turned off. An error was discovered in the method of analysis used for the LWP camera. This error resulted in degradation rates which were were too low, as given in Garhart, et al. (1989). The corrected LWP sensitivity degradation rates (-0.33 to -1.07 %/year) are now comparable to the SWP degradation rates. A detailed report is given in this newsletter.

VII. FES Sensitivity

A new time correction has been derived for calibrating FES magnitudes. Data for several calibration stars obtained using both the underlap and overlap FES modes were used for the analysis. The sensitivity seems to have been essentially unchanged for the first few years after IUE's launch, then started decreasing linearily with time. The rate of change and the time at which the sensitivity started to decrease seem to be somewhat different for the underlap and overlap modes, probably due to the development of the "fatigue spot" at the current reference point. A report on the FES time study and a general description of the FES are given in this newsletter.

References

Bruegman, O. and Crenshaw, D. M 1989. NASA IUE Newsletter, No. 37, p. 36.

Garhart, M.P., Oliversen, N. A., and Teays, T. J., 1989, NASA IUE Newsletter, No. 37, p. 71.

Grady, C., and Garhart, M. 1989. NASA IUE Newsletter, No. 37, 102.

Imhoff, C., Fireman, G., and Taylor, M. 1988. Report presented at the September 1988 IUE Three-Agency Meeting.

Press, W. H., Flannery, B. P., Tenkolsky, S. A., and Vetterling, W. T. 1986. "Numerical Recipes: The Art of Scientific Computing", Cambridge Univ. Press.

Reader, J., Acquista, N., Sansonetti, C. J., and Sansonetti, J. 1989. Preprint.