International Ultraviolet Explorer Atlas of O-Type Spectra From 1200 to 1900 Å

(Walborn *et el.* 1985)

Documentation for the Computer-Readable Version

Anne C. Raugh
October 1987

Doc. No. STX-T-1-3002-3104-87
Contract NAS 5-28752

Prepared for:
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

Prepared by:
ST Systems Corporation
4400 Forbes Blvd.
Lanham, Maryland 20706

Abstract

This document describes the computer-readable version of the *International Ultraviolet Explorer Atlas of O-Type Spectra From 1200 to 1900 Å* (Walborn *et el.* 1985) distributed by the Astronomical Data Center, NASA Goddard Space Flight Center. This catalog contains normalized fluxes, normalized flux quality factors, and splice points for 101 spectrograms of 98 O-type stars. Also included in the header for each set of spectrogram data are identification(s), spectral type, SWP number, and name of the principal investigator. The catalog is in two files, one containing the fluxes and quality flags, the other containing the splice points.

The present document describes the structure of the files overall and the individual data fields in detail.

Contents

List of Tables

1 Introduction

A copy of this document should be distributed with every copy of the machine-readable catalog.

1.1 Description

The *International Ultraviolet Explorer Atlas of O-Type Spectra From 1200 to 1900 Å* (IUEAOS; Walborn *et el.* 1985) lists normalized fluxes and flux quality factors, splice points, and identifying information on 101 spectrograms of 98 O-type stars. The catalog is presented in two files: the first containing the flux data, the second listing the splice points. Header records, which are identical in both files, list the object identification, spectral type, SWP number, principal investigator, and pages in the published atlas where the spectrogram(s) can be found. The procedures followed in processing the raw data to produce the final spectrograms are briefly described in Appendix A: "Data Preparation."

1.2 Reference

Walborn, N. R., Nichols-Bohlin, J., and Panek, R. J. 1985, *International Ultraviolet Explorer Atlas of O-Type Spectra From 1200 to 1900 Å* (NASA Reference Publication 1155).

2 Structure

2.1 Each File as a Whole

The IUEAOS consists of two files. Table 1 gives the tape-file attributes that are the same no matter what computer the catalog is copied for. All records are of fixed length. The first file contains the flux data (Table 3) and the second file lists splice points (Table 4). Detailed descriptions of each file are given in the following sections.

Quotations in any of the following descriptions come from Walborn et al. (1985) unless otherwise noted.

International Ultraviolet Explorer Atlas of O-Type Spectra From 1200 to 1900 Å (Walborn *et el.* 1985)				
File	Contents	Record Format	Record Length	Number of Records
1	Fluxes	Fixed	96	80901
2	Splices	Fixed	96	1010

Table 1: Summary Description of Catalog Files

2.2 Header Records

Header records are used to separate the data from successive spectrograms in the catalog files. These records contain descriptive information about the object observed, and follow the same format in both files.

Bytes	Suggested Format	Data
1-12	A12	Identification
13-14	2X	Blank
15-26	A12	Name
27-28	2X	Blank
29-44	A16	Spectral type
45	1X	Blank
46-50	I5	SWP number
51-52	2X	Blank
53-63	A11	Principal investigator
64	1X	Blank
65-69	A5	Atlas pages 1
70	1X	Blank
71-75	A5	Atlas pages 2
76	1X	Blank
77-81	A5	Atlas pages 3
82-96	15X	Blank

Table 2: Header Record Format (Both Files)

Identification HD or HDE number of the star. Two stars have no HD/HDE number; in one case this field contains the BD number, and in the other the Sanduleak number is listed. [bytes 1-12, format A12]

Name Bayer-Flamsteed designation of the star, if any, or (in three cases) an indication that the star is in the Large or Small Magellanic Cloud [bytes 15-26, format A12]

Spectral type Optical spectral classification by Walborn (1972, 1973) [bytes 29-44, format A16]

SWP number Short Wavelength Prime (SWP) camera sequence number of the observation [bytes 46-50, format I5]

Principal investigator IUE principal investigator [bytes 53-63, format A11]

Atlas pages 1 Location in the printed atlas of the first spectrogram for this object. Spectrograms extend over two pages so this field will always contain a value

such as *39-40*. This field and the following two fields can alternately be read with the FORTRAN format "I2, A1, I2." [bytes 65-69, format A5]

Atlas pages 2 Location of the second spectrogram, if any, in the printed atlas [bytes 71-75, format A5]

Atlas pages 3 Location of the third spectrogram, if any, in the printed atlas [bytes 77-81, format A5]

2.3 Fluxes (File 1 of 2)

This file lists pairs of normalized fluxes and the corresponding normalized flux quality factors for the 101 spectrograms of the IUEAOS. The values are listed four pairs to a line spaced in intervals of 0.25 Å in the range 1150.0 to 1949.75 Å. The wavelength of any pair can be determined by applying the following formula:

$$\lambda_{n_{ij}} = 1149.0 + i + 0.25(j - 1)$$

$$\begin{aligned} \text{where} \quad i &= \text{row number} \\ j &= \text{pair number} \end{aligned}$$

There are one header line and 800 data lines in this file for each spectrogram.

Bytes	Suggested Format	Data	
1-12	E12.5	Norm. flux	1
13-24	E12.5	Norm. quality factor	1
25-36	E12.5	Norm. flux	2
37-48	E12.5	Norm. quality factor	2
49-60	E12.5	Norm. flux	3
61-72	E12.5	Norm. quality factor	3
73-84	E12.5	Norm. flux	4
85-96	E12.5	Norm. quality factor	4

Table 3: Flux File Data Record Format

Norm. flux Normalized flux. See Appendix A: "Data Preparation" for a brief description of how this value was calculated. [bytes 1-12, 25-36, 49-60, and 73-84, all format E12.5]

Norm. quality factor Normalized quality factor. See Appendix A: "Data Preparation" for a brief description of how this number was calculated. [bytes 13-24, 37-48, 61-72, and 85-90, all format E12.5]

2.4 Splices (File 2 of 2)

This file lists pairs of wavelength values indicating the points of overlap where successive orders of the IUE spectrum have been spliced together. There are 52 pairs for most spectrograms (nine of the spectrograms have only 50 pairs), listed six pairs per record. Each spectrogram has one header record and nine splice point data records in this file.

Bytes	Units	Suggested Format	Data	
1- 8	Å	F8.1	Beginning wavelength	1
9-16	Å	F8.1	Ending wavelength	1
17-24	Å	F8.1	Beginning wavelength	2
25-32	Å	F8.1	Ending wavelength	2
33-40	Å	F8.1	Beginning wavelength	3
41-48	Å	F8.1	Ending wavelength	3
49-56	Å	F8.1	Beginning wavelength	4
57-64	Å	F8.1	Ending wavelength	4
65-72	Å	F8.1	Beginning wavelength	5
73-80	Å	F8.1	Ending wavelength	5
81-88	Å	F8.1	Beginning wavelength	6
89-96	Å	F8.1	End wavelength	6

Table 4: Splice Data Record Format

Beginning wavelength Wavelength of the beginning of the next (higher) order [bytes 1-8, 17-24, 33-40, 49-56, 65-72, and 81-88, all format F8.1]

Ending wavelngth Wavelength of the end of the previous (lower) order [bytes 9-16, 25-32, 41-48, 57-64, 73-80, and 89-96, all format F8.1]

3 History

3.1 Remarks and Modifications

The *International Ultraviolet Explorer Atlas of O-Type Spectra From 1200 to 1900 Å* (IUEAOS) was received by the Astronomical Data Center (ADC), NASA Goddard Space Flight Center, from J. Nichols-Bohlin in May 1987. The original data came in the form of 202 separate files: two files for each spectrogram, one containing the normalized fluxes and flux quality factors, the other listing the splice points. These files were resident on the Interactive Astronomical Data Analysis Facility (IADAF) VAX 11/750. A Forth program was run to concatenate all files into a single file, which was then copied to tape. This tape file was copied to disk on the NASA Space and Earth Science Computing Center (NSESCC) IBM 3081. FORTRAN programs were run to separate the fluxes and splice points into two separate files and to reorganise these files

into the format described in the previous sections. Working from a copy of Walborn *et al.* 1985, ADC personnel keyed the header information for each object into a third file. A FORTRAN program was then run to insert these header records into both files.

A final FORTRAN program was run to check the validity of each field according to its data type and value.

3.2 Reference to the Documentation

Nichols-Bohlin, J. 1987, private communication.

Walborn, N. R. 1972, *Astrophys. J.*, **77**, 312.

Walborn, N. R. 1973, *Astrophys. J.*, **78**, 1067.

Walborn, N. R., Nichols-Bohlin, J., and Panek, R. J. 1985, *International Ultraviolet Explorer Atlas of O-Type Spectra From 1200 to 1900 Å* (NASA Reference Publication 1155).

A Data Preparation

This section briefly describes the steps involved in selecting and processing the data comprising this atlas. The following description was extracted from an edited version of Walborn *et al.* (1985) kindly supplied by J. Nichols-Bohlin.

A.1 Selection

Approximately 200 O stars have short-wavelength, high-resolution data in the IUE archive. 120 of these were examined for possible inclusion in the IUEAOS. "The primary selection criterion was the availability of homogeneous optical spectral classifications by Walborn (1972, 1973). In general, known interacting binaries and very rapid rotators were avoided, but a number of peculiar objects and categories which have been well described optically were specifically included."

A.2 Processing

The IUE Spectral Image Processing System (IUESIPS) data were retrieved from the IUE data archive. Each gross spectrum included "samples of the observed signal along each echelle order, integrated along a pseudo-slit; and a corresponding sample of the interorder background." Sample wavelength and a data quality indicator were also included. Processing then proceeded through the following steps:

1. The background was smoothed and subtracted from the on-order signal to yield the net spectrum.

2. A "ripple" correction was applied to adjust for systematic variation along each order caused by the varying sensitivity of the echelle grating. "Overlap among adjacent orders [was] discarded beyond the wavelengths at which which the sensitivities [were] equal." These points of overlap are listed in the second file.

   The spectrum was then resampled to 0.25 Å resolution:

   > Each original sample was considered an estimate of the flux averaged over a bin whose width was equal to the spacing between the adjacent points. Each new sample was computed as a weighted average of the original samples; the weight of each original sample is equal to the fraction of its bin which falls within the 0.25 Å window centered on the new wavelength point. However, the weight is zero for any original point for which the IUESIPS quality factor indicated contamination by a camera reseau, saturation of the vidicon camera, or a particle radiation hit. The new sample points were spaced evenly at 0.25 Å intervals from 1150 Å to 1950 Å. For each new sample point, a quality factor was computed as the sum of the weights for the original samples contributing to the new point. This quality factor ranges from about 6 at 1200 Å (where there is no effect of a reseau, etc.) to about 4 at 1800 Å for IUESIPS processing at

GSFC before November 1981. With the newer version of IUESIPS, this factor is roughly doubled due to the finer wavelength sampling of the spectrum.

3. The resampled spectrum was then rescaled in order to locate the stellar continuum at an approximately uniform level:

   > This ... was performed interactively ... by identifying about a dozen "continuum" points spaced along the interval 1150-1950 Å. Then, the flux was divided by a cubic spline interpolated through these points. The intention here was not to precisely define a stellar continuum; it was simply to place the spectrum onto a convenient scale for plotting over the full spectral range. The renormalization function usually showed a broad hump between 1400 and 1600 Å. It is unclear whether this represents a rise in the instrument sensitivity near 1500 Å or an effect of blended spectral absorption features near 1400 and 1600 Å. Similarly, the data quality factor was normalized to remove the effect of the decreasing spectral dispersion toward longer wavelengths, which causes the number of original samples within a 0.25 Å window to decrease.
   >
   > Narrow positive spikes in the flux data due to particle radiation hits and the geocoronal Lyman alpha emission were eliminated manually.

   The normalized fluxes and corresponding normalized quality factors are listed in the first file.

In addition, the catalog authors note the following:

> Small deviations from unity in the data quality factor occur where a few of the original sample points in the 0.25 Å resample window were contaminated by a reseau. Large deviations from unity occur where most or all of the points were affected by a reseau. In many cases, no effect of the reseau is apparent in the stellar spectrum; this occurs when the reseau falls close to but not precisely onto the stellar spectrum, and the interorder background is weak.