OPTION 15. CONTINUUM FITTING

Here one can automatically fit a continuum by using an existing continuum file (λ, $\Delta\lambda$, height) to define where the continuum is to be measured and then interpolate amongst these data to complete the rectification. See description of CONTINUUM file later (15-4). In this mode, prior to rectifying the data, one can step through the spectrum comparing the interpolated continuum with the raw data by adding, replacing and deleting values at will to improve the representation. When averaging data to find a continuum value, one can also select the % of the highest values one wants to average over; 75% is default value (see 15-4). One can also edit bad data. In the alternative mode one steps through the spectrum defining or measuring continuum values by means of the cursors. The resultant files can be stored for use with other stars or for other spectra of the same star to avoid unnecessarily repeating the process.

STEP 1 PROMPT: Enter continuum file name. To repeat the same file enter SAME. Follow it by the continuum file name. Can reset it at the next step.

Verify or measurement mode: V at 1st record, W at given lambda, R=restart.

Reply. R to jump out to the OPERATIONAL OPTIONS Table.

V or W will lead one to the manual measurement of the continuum (see step 6).

V at the first record, W at a specified wavelength.

End with E on first setting. To change continuum file enter C. If you enter SAME then you can bypass having to answer this question each time.

Enter the CONTINUUM FILE NAME. If one elects to use this automatic fitting mode the spectrum is displayed on the screen and the adopted continuum graphed through the data. Prior to accepting or rejecting the fit one is asked to remove any continuum points near gliches in the data.

STEP 2 PROMPT: EDIT CONTINUA? N = No, otherwise use PAIRS of CURSOR settings End with E on first setting. To change continuum file enter C.

Reply. If there are bad data displayed delimit the areas with the X cursor. End the series of pairs of settings with an E after the final pair have been entered. By this process the adopted continuum is modified to exclude bad data. Later in the verification mode (step 4) these bad data can be edited.

If you want to change the continuum file after using SAME in Step 1, enter C.

After the continuum has been graphed the following prompt appears

STEP 3 <u>PROMPT</u>: CONTINUUM OKAY? Y, N = Repeat, V = Verify, W = Verify at specific lambda, R = Restart sequence.

Reply. Y to proceed with the rectification and to STORE the rectified file.

N Repeat sequence.

R means to abandon the continuum fitting and skip to the OPERATIONAL OPTIONS Table.

V means that one wants to verify the adopted continuum by stepping through the spectrum. In this case the first 1800 data values will be plotted and the current continuum graphed through the data. You are now prompted to modify the continuum points, to plot new data or to accept the display. Any changes to the continuum can be immediately displayed on the screen.

W allows one to begin the verification at a specified wavelength. Will prompt for a starting wavelength.

Begin verification procedure.

STEP 4 <u>PROMPT</u>: Verifying Options: <X>NP%K CLADTBYZ, E=End Verif., R=Abandon, W=Skip to particular wavelength, J=Edit bad data
These commands will not replot continuum B=Add, Y=Delete, Z=encode ht

The first 7 options control the display.

< Moves the displayed spectrum to the left (shows longer wavelengths) by 20% (default value) of 1800 data points (default value).

X Expands the number of data displayed by 2 times 20%.

> Moves the displayed spectrum to the right (shows shorter wavelengths) by 20% (default value).

N Changes the number of data points displayed.

P Controls whether the data is plotted as points (default) or lines.

% Changes the % that the data are shifted or expanded.

K Will not plot all data points. Skips data so that only 1800 are plotted. Good for B stars, not so hot for late-type stars.

These options control the continuum values

A is used to add a continuum value by one making <u>two</u> cursor placements. The data within such a window will be averaged and continuum replotted.

T is used to fix (and add) a continuum value at an XY position. The width stored in the continuum file is 1 Angstrom. The continuum will be replotted.

D will delete the continuum value under the cursor and replot continuum.

L Allows you to change the continuum placement within the selected data; default value is 75%. Prompts for a new value of CFRAC (see 15-4).

C Skips to the plot of the next N points.

E Ends the verification (or measuring) process.

R Abandons the current process and can lead the user to the OPERATIONAL OPTIONS Table.

W Enables one to skip to a specific starting wavelength. One is PROMPTED. ENTER DESIRED STARTING WAVELENGTH. A total of 1800 points will be plotted.

J Enables one to edit poor data by interpolating between two cursor settings. Set the XY cursor to left-hand side of the data to be edited. Enter J. One is then PROMPTED. NOW ENTER RIGHTMOST LIMIT Now set the XY cursor to the rightmost position. Linearly interpolated data will be displayed after this setting.

The following options will allow continuum points to be added or deleted without allowing the continuum to be replotted.

B Add a point (same as A above)

Y Delete a point (same as D above)

Z Add a point using Y cursor (same as T above)

At the end of verification and modification process one is prompted.

STEP 5 PROMPT: CONTINUUM OKAY? Y, V = Verify again, R = Restart Sequence
S = Yes + STORE MEASURED CONTINUUM FILE

Reply. Y to STORE the rectified file under its current name but with the first character replaced by an R.

V means to run through the verification again (STEP 4).

R skips to the OPERATIONAL OPTIONS Table.

S STORES the measured continuum file (λ, $\Delta\lambda$) for use with other spectra after you give it the name that the continuum file will be stored under (see 15-4). In addition the rectified FITS R File is stored.

STEP 6 Consider STEP 1 again. If one elects to measure the continuum at STEP 1 (VW= No = manual mode) then one enters at STEP 4 with the first 1800 data points displayed on the screen. Many of the same options are available as in the verification step (STEP 4) but the continuum fit is not displayed (it is not defined yet). The continuum will be placed amid the top 75% of the data (default value).

A continuum point may be measured by making 2 cursor placements. The data within the bounds will be averaged (see Option L page 15-3) and this average value is displayed.

Alternatively, one can set the continuum height by using the X and Y cursors and entering a T (see 15-3). Make your measures in this way and fetch the next record by entering C. No continuum will be drawn between the measures, to see this you will have to complete all the measures — when you will then be back at Step 5. Here the verification and editing can begin.

PROMPT: Measuring Options: <X>NP%K TCL F=Finished measuring, R=Abandon. No continuum is plotted in the measuring mode (it hasn't been defined).

Reply. These commands are described in STEP 4. A measurement of continuum can be made by the T command which defines the continuum at the XY cursor position or by two cursor placements (similar to the A command in STEP 4) for each continuum point. Enter C to continue with the next block of data.

After one exits from the manual mode the program is at STEP 5 and the measured continuum can be edited or augmented by the verification procedure previously described.

DESCRIPTION OF CONTINUUM LINE FILE

As noted at the start of this Option (15-1) the continuum height (h) may be caluclated from the existing data. A simple file containing the fractional placement of the continuum within $\Delta\lambda$ of the continuum λ, corrected for a RV shift in a rich spectrum, may be all that is needed. This scheme does work well in an early type star but is inadequate for late type stars since the continuum may lay above the highest data values. The new program has 3 choices:

i) Calculate h at $\lambda \pm \Delta\lambda$ using a fraction or all of the data. Note that λ may need to be shifted to compensate for the star's velocity.

ii) Use a previously measured h (would only work if this was taken from a measure of the same spectrogram).

iii) Calculate h by setting it at a fraction of then height of the max data height found within $\lambda \pm \Delta\lambda$ (corrected for RV).

We will give examples of this later, we turn now to the structure of the continuum file.

Line 1. CFRAC, RV

CFRAC controls the fractional placement of the continuum within the specified λ range $(\lambda \pm \Delta\lambda)(1+RV/3\cdot10^5)$. Here the data are ordered in descending order and the fraction CFRAC taken. When CFRAC = .25 the highest 25% of the data are averaged. When CFRAC = 1 all of the data are averaged.

CFRAC also triggers the use of the inputted continuum height h (line 2...). If CFRAC is -ve then h will either be used directly or if h itself is -ve (and a fraction of unity) the continuum will be calculated as a fraction of the maximum data height within the window $(\lambda \pm \Delta\lambda)(1+RV/3\cdot10^5)$. The RV is needed to modify the continuum λ's. This is necessary in rich spectra since the star's RV is often enough to move the continuum.

Line 2. λ, Δλ, h

λ is the central wavelength of the continuum point.

±Δλ is the range about this wavelength over which the data are to be averaged.

h is the continuum height, either from a previous measure when a continuum is written to disk, or as a fraction of the expected local maximum. In the latter case REDUCE knows that provided h is entered as a -ve value (-1.10 means that the continuum is 10% above the local maximum).

Line 3. λ, Δλ

Example 1. Measure continuum in a B star

line 1: 0.75 0.0

line 2: 4200 2. 2.5

Result: Average the highest 75% of the data between 4200± 2 Å.

Example 2. Repeat the measure of star whose continuum values you know

line 1: -0.75 0.0

line 2: 4200 2. 2.5

Result: Adopt a height of 2.5.

Example 3. Set the continuum height as a function of the highest data value.

line 1: -0.75 20.0

line 2: 4200 0.4 -1.10

Result: Move the continuum wavelength to $\lambda(1. + 20/3\cdot10^5)$ Å to allow for the velocity shift of 20 km s^{-1}. Find the local maximum (m) within ± 0.4 Å of the revised λ. The continuum is then h = 1.10 m.