Calculation of Equivalent Widths via an Interactive Display Device

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ABSTRACT

This paper describes a computer program used to compute equivalent widths via an IBM 2250 attached to an IBM 360/75J.

The measurement of stellar equivalent widths is a long tedious procedure and the final results depend to a large extent on where the stellar continuum is drawn. Therefore, a method which permits the continuum to be redrawn and the equivalent width remeasured quickly is desirable. An interactive CRT display device is an ideal instrument for allowing an astronomer to adjust the continuum level and the other parameters that are involved in equivalent width measurements. The display device discussed in this paper is an IBM model 2250 used in conjunction with a IBM 360/75J.

The "2250" consists of a 12 inch (30 cm) square CRT display tube plus a 32 function key box, an alphanumeric keyboard and a light pen which can be pointed at any illuminated spot on the screen. Thus, there are 34 interrupts that can be sensed by the program controlling the "2250". The program that has been used communicates with the astronomer via messages and questions displayed on the CRT screen. The main program remains in a wait state until one of the 34 possible interrupts occurs, whereupon it branches to the designated subroutine and executes the procedures necessary to satisfy the interrupt.

The first step in a given run is to select the spectrum that is to be analyzed. This is accomplished by the program asking WHICH SCAN and the astronomer typing in, via the alphanumeric keyboard, a number that identifies the desired spectrum. When the data has been read into the computer the identifying information (star name, scan number, wavelength range, date and time of observation) are displayed so that the astronomer can verify that he has obtained the desired spectrum. Next, by means of a function key, a grid is displayed and the astronomer is asked to choose what portion of the spectrum is to be displayed; when he has replied, via the keyboard, the spectrum appears on the screen for his inspection. At this point, he has several options that can be performed on the displayed data: it can be smoothed, using a running average or a simple average of several adjacent values; it can be compressed by deleting every other point in order to see a wider wavelength range; if the original data is photographic density, it can be converted into intensity via a characteristic curve that has been read in, or it can be shifted backwards or forwards to center a particular region of the spectrum on the tube.

After arranging the spectrum to his satisfaction, the astronomer is ready to attempt to draw the continuum. At the current stage of this program, it is only possible to draw a straight line between two points. The points are determined by pointing to the display somewhere in the continuum on either side of the line in question. The continuum level is then displayed and can be checked. The equivalent width is computed from

$$W_\lambda = \int_{\lambda 1}^{\lambda 2} (1 - F_L/F_C) d\lambda$$

where λ_1 and λ_2 are the wavelengths chosen by the astronomer to start and end the continuum, F_L is the flux in the line and F_C is the flux in the continuum. In order to make one last check, the integrand is displayed before the computation is made. This permits the astronomer to check for asymmetry or incorrect continuum levels. Then, with the pushing of a final function key, the integral is performed using a trapezoidal integration scheme, and the result displayed on the screen for checking and recorded on the printer for later retrieval. At any point in the process the astronomer can go back to an earlier step and start over from that point.

It should be pointed out that this program is very modular in design and any one of the subroutines which respond to a given interrupt can be easily modified or replaced. For example, the routine

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that reads in the data can be easily changed to accept a different format from the data tape; the averaging routine could be rewritten to do least squares or Fourier transforms.

At the beginning I mentioned speed and efficiency of doing equivalent width measures as an important facet. This program typically runs in a normal multi-program batch job stream along with 4 to 5 other jobs on a 360/75J; in fact, the graphics jobs are usually stored in a slow-speed core and hence operate at a slower rate by a factor of 2 or 3. Nevertheless, if the equivalent width program has an equal priority with the other jobs in the system, I can not work fast enough to keep ahead of the program *i.e.*, the response time is instantaneous, and the other jobs do not feel the effect of the graphics job. In an hour of sitting at the "2250" terminal it is possible to make 2 or 3 measures on about 70 lines and use less than 4 minutes of computing time. This program was written by one man (Mr Charles Summers) over the course of one year and it was his first FORTRAN program. With all due respect to Mr Summers, I am sure that this program could be speeded up by a factor of 2 to 5, thus becoming a very efficient tool for the astronomer.

DISCUSSION

W. A. SHERWOOD: Does your program produce a numerical estimate of error in fitting the continuum or is it mainly a "best fit" by eye?

D. A. KLINGLESMITH: I don't have any numerical estimate.

J. B. HUTCHINGS: Can you fit only a straight line to the continuum?

D. A. KLINGLESMITH: At this point, yes. I don't make any attempt to rectify the spectrum, but that's in the design stage.

C. L. STEPHENS: Does the IBM system incorporate a tracking cross, and if so wouldn't this solve the problem of obtaining a good fit to the continuum?

D. A. KLINGLESMITH: The particular model 2250 we have doesn't have that feature; it could however be programmed to do it.

C. L. STEPHENS: If you start doing that, would you use a lot more central processor time?

D. A. KLINGLESMITH: Not too much; I'm sure this program could be speeded up by a factor of 5 or 10 easily.

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