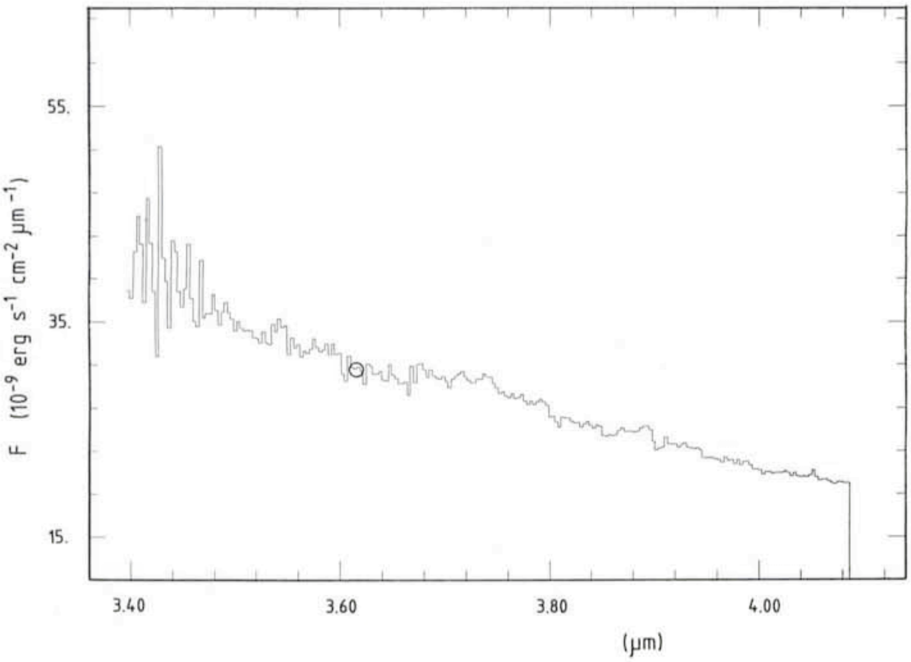

Figure 1: *Reduced spectrum of the standard star HR 5459, calibrated using the standard star HR 6746. The circle corresponds to the flux of HR 5459, determined photometrically in the L band.*

tion (see refs. 2 and 3 for details about the data format).

The basic steps of the basic IRSPEC reduction are:

(1) To perform wavelength calibration. The wavelength calibration is made by converting pixel positions into wavelengths, using a polynomial fit to laboratory measurements of a spectral calibration lamp and the theoretical dispersion formula. This calibration is done in a fully automatic procedure. As explained in ref. 2, the observer does not need to worry about making independent wavelength calibration, as the laboratory calibration formula provides accuracy to a fraction of a pixel. The grating position and stability of the instrument may be checked before each observing night in the way described in ref. 2. As a matter of safety, the observer may also record calibration spectra of any of the spectral line lamps available.

(2) To detect and correct "spikes" present in the scans. During this interactive step it is possible to reject individual pixels in a given scan or to eliminate one or several scans completely. New average counts with corresponding errors are then calculated using the selected information.

(3) To merge all spectra taken with the same wavelength parameters in a table. This table will be used as a working space where all the reduction operations will be carried out. Therefore, it is essential to make the observations of programme objects and standard stars – and optional calibration lamp exposures – in sets with *precisely the same wavelength parameters.* Otherwise, each individual spectrum, calibrated in wavelengths, will have to be rebinned into an image file, losing the possibility of error information and decreasing the flexibility of the reduction scheme.

(4) To compute the ratios between object counts and standard star counts. The detailed mathematical computations between spectra are decided by the user, depending entirely on the programme and methodology set by the observer. Basically, the result will be a series of spectra of programme objects divided by standard stars, cancelling in this way both the instrument response and atmospheric transmission characteristics.

(5) Flux calibration. This is done by fitting the coefficients A and B in the function $F_\lambda = A\lambda^B$ to the broad-band photometric data of a selected standard star. The coefficients are then used to convert the count ratios, computed in the step above, into flux. Tables with the fluxes of the observed standard stars have to be provided. Because of the flexibility of the reduction scheme, it is possible to select the standard stars from the ESO list of JHKLM standards, with the user's choice of zero-magnitude fluxes, or to include tables with standard stars defined in the system of your choice.

(6) To convert the final reduced spectra into one-dimensional images, so that any of the standard spectral analysis commands may be used.

At any of the previous stages, it is possible to generate plots or to use any of the available table commands to interact with the intermediate results. The present implementation includes a tutorial procedure to illustrate all the reduction steps described above.

3. Comments on the Accuracy of the Reduction

The actual accuracy achieved in the wavelength calibration step depends on how well calibrated the grating position was at the time of the observations. Naturally, this can be checked before each observing night. The estimated rms error for the measured lines in four independent calibration lamp exposures in the J and H bands was 0.0002 µm, which is about two tenths of a pixel.

The flux calibration is, at present, accurate to at best 5%. This depends strongly on the choice of the standard star and, naturally, on the sky transparency stability. As an illustration, Figure 1 shows the spectra of the standard star HR 5459 calibrated using standard star HR 6746, this time in the 3.5 to 4.05 µm region. The symbol ◯ marks the L band flux of HR 5459 determined photometrically.

As another example, the J band IRSPEC spectrum reduced with the MIDAS IRSPEC reduction package of the supernova 1987A in the Large Magellanic Cloud is shown in Figure 2. These data were obtained by T. Le Bertre the night of 29/30 May 1987. Figure 2a displays the counts with associated error bars. Figure 2b is the calibrated flux, the symbol ◯ marks the independent J-band photometric flux corresponding to that night.

Acknowledgement

We are indebted to A. Moorwood and A. Moneti for their contributions during the design of the reduction method. We

ESO Book Soon Available in Spanish and French

A Spanish edition of the ESO book "Exploring the Southern Sky" (see the *Messenger* **49,** 43) is now being prepared. It will soon become available in major bookstores in Spain and other Spanish-speaking countries, also in South America. Information about this edition may also be obtained from the publisher: Equipo Sirius (Tribuna de Astronomía), Desengaño 19–10°, E-28004 Madrid, Spain (telephone: [91] 5216008).

A French version will become available from Les Editions de Physique later this year.