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Properties of the EXPORT sample: Spectral type determination

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Abstract. In this paper we present the results of the spectral classification of stars included in the EXPORT (EXoPlanetary Observational Research Team) sample and observed during the 1998–1999 International Time campaigns in the Canary Island observatories. Intermediate resolution spectra obtained with the Isaac Newton Telescope (INT) were used in this work. In addition to the confirmation of some spectral types and changes to previous classifications, we report new results for stars whose spectral type had not been accurately assigned before.

1. Introduction and motivation for this work

The knowledge of all the relevant parameters of stars showing protoplanetary disks, envelopes or any trace of circumstellar material, or planets orbiting around, is a crucial point for understanding the evolution of these objects and the formation processes of planetary systems.

During the four International Time campaigns (Eiroa et al. 2000), the INT was devoted to obtain intermediate resolution spectra of targets of interest for establishing an evolutionary sequence covering from objects with protoplanetary disks in the pre-main sequence, to objects similar to β Pic, stars showing the Vega phenomenon and stars with planets already formed.

One of the goals of these observations was the analysis of the spectral features appearing in the spectra and their comparison with standard, normal stars, leading to a revision of the available results on spectral types for some of the targets and to a classification for stars poorly studied previously.

2. Tools for the spectral classification

The spectral classification has been done by comparing the spectra of the targets with those of standard stars. Also, Kurucz models have been fitted to the dereddened IUE spectra of the problem stars -when available- and their calculated

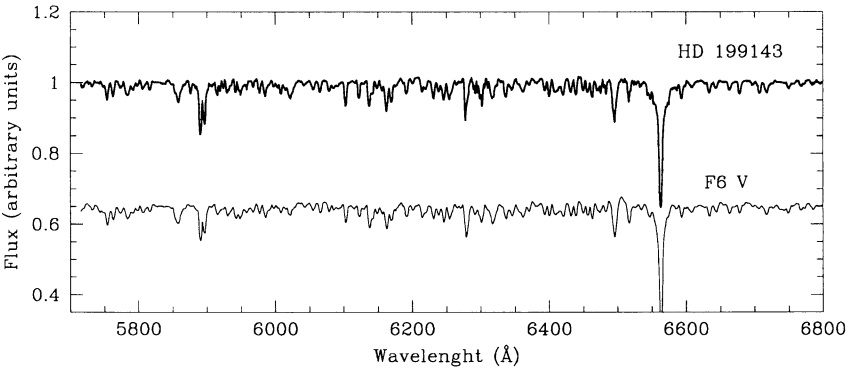

Figure 1. Example of the classification for a HAeBe/ZAMS star. The thick line shows the average normalized spectrum of HD 199143 taken with the INT by EXPORT, the thin line is the spectrum of the standard star HR 4606 observed by EXPORT which had been previously broadened with a rotational profile for $v \sin i = 140$ km/s.

absolute magnitudes from Hipparcos parallaxes have been compared with those tabulated for standard stars.

2.1. Comparison with INT spectra of standards

The spectral comparison has been done by using spectra of standard stars with well-determined spectral types, taken during the EXPORT runs. A library of high and mid-resolution INT spectra of standard stars (Montes et al. 1997) was also used to more accurately determine the spectral type of the cool stars in the sample.

First of all, an approximate classification was done by a visual inspection of the spectra. After this step, the comparison spectra were broadened using a rotation profile with the value of $v \sin i$ of the target star. The formalism given by Gray (1992) was applied. Most of the $v \sin i$ values used here were computed by EXPORT members using high resolution observations obtained during the four campaigns with the William Herschel Telescope (Solano et al. 2000). The broadened standard spectra were then compared with the target spectra, allowing the determination of the spectral type.

The main problems we have found in doing this were: i) the presence of non-standard features such as DIBs (Diffuse Interstellar Band) or lines produced in the circumstellar envelope of the star, ii) the blended lines in rapid rotators and iii) the veiling in T Tauri stars.

Figure 1 shows an example of this comparison for the HAeBe/ZAMS star HD 199143.

2.2. Fitting of Kurucz models to IUE spectra

The INES database (http://ines.vilspa.esa.es) was searched for IUE spectra of every star in the EXPORT sample. When some IUE spectra were available

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for any problem star, these were retrieved, interactively coadded, merged and dereddened. After this, Kurucz models were compared with the final averaged IUE spectrum of the star determining the effective temperature and surface gravity from the best fit. The ATLAS9 Kurucz models with solar metalicity (1993) were used in this work.

Also, for stars with spectral type earlier than A0 V and with enough flux in the ultraviolet, a direct estimation of the reddening was performed by dereddening the IUE spectrum with different values of $E(B-V)$ until the 2200 Å feature (thought to be produced by interstellar graphite) disappeared.

2.3. Estimate of the absolute magnitude

For those stars in the sample whose distance was well known, the absolute magnitude was calculated from the apparent V magnitude observed by EXPORT, the estimated reddening and the distance. This value was then compared with those tabulated in Schmidt-Kaler (1982) for standard stars. This informs about the luminosity of the star and helps to the luminosity class determination.

3. Results and comments

We have very accurately determined the spectral type of 65 stars in the EXPORT sample. Out of them, 51 stars (78%) have been classified with an error less than two spectral subclasses and 14 (22%) with an error of up to five spectral subclasses. 22 stars (34%) had an incorrect spectral type from previous works and 7 (10%) had no previous spectral type assignation.

Other goals of this classification have been the discovery of stars in different evolutionary states from those previously thought and the empirical confirmation of the projected rotational velocities $v \sin i$ calculated by members of the EXPORT team (Solano et al. 2000).

Work is in progress to determine the spectral type of the whole EXPORT sample observed with the INT (81 stars). The final result of this classification as well as the projected rotational velocity determinations will be published elsewhere soon.

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