ANALYSIS OF UV SPECTROPHOTOMETRIC OBSERVATIONS FOR O-TYPE STARS.

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The ESA "Ultraviolet Bright Star Spectrophotometric Catalogue" (Jamar et al. 1976) and the "Catalogue of 0.2 A Resolution Far-ultraviolet Stellar Spectra Measured with Copernicus" (Snow and Jenkins 1976) have been used to try to separate, by means of simple diagrams, O-type stars belonging to different luminosity classes and having different temperatures. The ESA catalogue gives absolute fluxes for 43 O-type stars, mostly reddened, with a spectral resolution of 35-40 A, depending on the channel, in the wavelength range 1350-2550 A. The Copernicus catalogue gives spectra between 1000 and 1450 A for 17 O-type stars, with low reddening, at 0.2 A resolution.

We have selected 32 stars from the ESA catalogue with known spectral class and reddening and calculated the spectral indices Δm_{2100} and Δm_{1500}, after having corrected the observed fluxes for the color excess with the mean interstellar law of Code et al. (1976). The spectral indices, defined by the following relation

$$\Delta m_\lambda = (m_\lambda - m_{5500})_{star} - (m_\lambda - m_{5500})_{Vega}$$

are the difference of flux, expressed in magnitudes, at λ, between the star and Vega, when the observed spectra are normalized to 5500 A. From the RMS deviation of the observations used to compute the mean fluxes, we have estimated the error in the spectral indices to be on the order of 10% or less. Additional errors of about 15% are due to the calibration of the instrument (Jamar et al. 1976). The dependence on the assumed mean interstellar extinction law has been tested by comparing our spectral indices with the Δm_λ calculated using the law of Nandy et al. (1976). The difference is unappreciable at 2100 A and very small (about 3% for star with E(B-V)=0.6) at 1500 A. A table with all the data is available on request.

Theoretical indices have also been calculated from the grid of LTE line blanketed model atmospheres of Kurucz, Peytremann and Avrett (1974) by taking different values of T_{eff} and log g appropriate to O stars, and using a "theoretical" model of Vega with fluxes at 1500, 2100 and 5500 A given by the observations. Figure 1 reports the curves for Δm_{2100} and Δm_{1500} versus the effective temperature, and the position of the observed indices on a temperature scale given by

P. S. Conti and C. W. H. de Loore (eds.), Mass Loss and Evolution of O-Type Stars, 109–112.

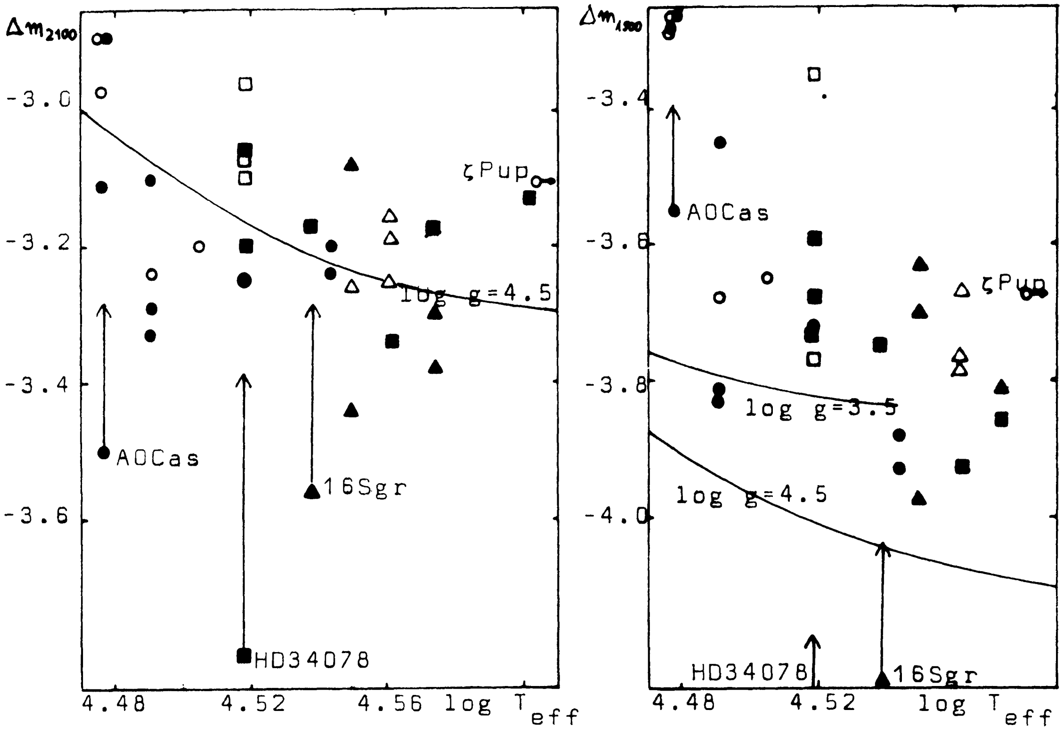

Figure 1: The spectral indices versus log T_{eff}. Circles are supergiants, triangles are giants, squares are dwarfs. Black symbols refer to stars with E(B-V) 0.2.

Conti's (1973) spectral type - effective temperature relation. The fluxes are not very affected by line blanketing in this region, and are still far from the maximum of the Plank curve. Thus one expects that the Δm_{2100} indices are almost independent of the luminosity. This is confirmed by the negligible separation (not shown in the figure) of the theoretical curves for the two values of log g=3.5 and 4.5 . The m_{1500} curves are both temperature and gravity dependent. We are measuring a region which is rich in lines of highly ionized elements; thus more flux is absorbed by lines at lower gravities. The observed points are systematically above the theoretical curves, probabily because the models both do not include all sources of line opacity, and underestimate the flux absorbed by the available lines. This last argument is particularly significant for explaining the large separation from the theoretical curves of most of the supergiants of our sample: the models have been calculated with a 2 km/s velocity of microturbulence, which is much less than the generally adopted values for hot supergiants. In addition the observed fluxes may be influenced by the displaced envelope component of the strong resonance line doublet of C IV at 1548-50 A.

There is evidence, in figure 1, of a well established relation between observed spectral indices and empirical temperatures. A satisfactory agreement with the models is also achieved for the 2100 indices. The stars which show greater deviation from the mean relations have probably an incorrect value of the reddening parameter, or an incorrect spectral class assignation. To illustrate the effect of a bad choice of E(B-V) we have calculated the Δm_λ indices for A0 Cas, HD 34078 and 16 Sgr with 10% less reedening. The indices go up to the values indicated by the arrows. For ζ Pup the situation is unclear: the spectral indices require a lower temperature, but this might be a spurious effect due to the presence of numerous emission lines throughout the spectrum.

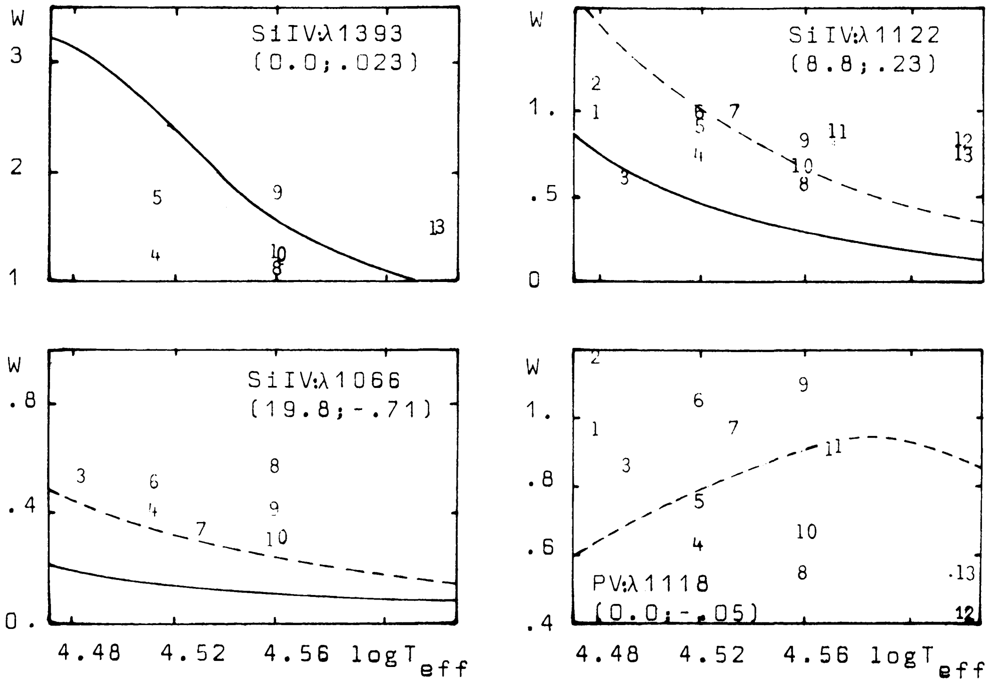

Figure 2: Theoretical and observed equivalent widths (in A); dashed curves are computations with $\Gamma = 10 \times \Gamma_{cl.}$; numbers in parentheses are the excitation potential (in eV) and log gf respectively. 1-ζOri, 2-μNor, 3-τCMa, 4-μCol, 5-ζOph, 6-δOri, 7-ιOri, 8-10Lac, 9-λOri, 10-15Mon, 11-ξPer, 12-HD199579, 13-9Sgr.

Ultraviolet spectroscopic criteria for the separation of O stars into their different spectral classes have been investigated by comparing equivalent widths of selected lines with LTE model atmosphere computations. The equivalent widths have been measured from the

Copernicus spectra with the usual method of drawing a local continuum and integrating the line profile over an appropriate wavelength interval. After a careful inspection of the tracings and of the available identification lists, we have measured the photospheric lines presented in figure 2: their equivalent widths are given versus the temperature determined from the spectral type.

Theoretical line strengths, computed with a code that solves the LTE line transfer problem from the model atmosphere input of Kurucz, Peytremann and Avrett at log g=4.5 and different values of the temperature, are also given in figure 2. We have assumed solar element abundances and a constant value of the microturbulence velocity of 5 km/s. Although the number of observations is too small and the theory used is not fully appropriate (we should have used, for example, more realistic values for log gf and non-LTE theories), nonetheless the general behaviour of the silicon lines looks consistent with the computations. It is not so for the P V resonance line, whose equivalent widths appear scattered on the W-log T_{eff} plane, as if some unidentified blended component contribute to the line. The separation by luminosity classes is not seen in the diagrams of figure 2.

We are presently working on improving the equivalent width obsevations over a larger sample of stars and taking other lines into account. In the near future, we hope to be able to drawn a more consistent picture of the relations between O star spectral classes and UV spectrophotometric observations.

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