A NOTE ON THE CALIBRATION OF EFFECTIVE TEMPERATURES

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ABSTRACT. The discrepancy in the derived chemical compositions between B-A1 stars and stars of later spectral types can be removed if another T_{eff}-calibration is applied for A and F type stars than the one usually used.

1. MASS-EFFECTIVE TEMPERATURE RELATIONS

In the lower part of Figure 1 the experimental ($M/M_{\odot}$, T_{eff}) relations according to Habets and Heintze (1981) and Schmidt-Kaler (1982) are given together with the theoretical relation of Straižys and Kurileiné (1981) for stars of 2.3 to 0.9 solar masses. In that mass range the difference between Habets and Heintze and Schmidt-Kaler is considerable, except for the Sun. For masses exceeding five solar masses this difference becomes smaller. The relations of Straižys and Kurilienė, for the main sequence stars with masses larger than that of the Sun, agree rather well with that of Habets and Heintze (1981). This is not true for the gravities of stars of luminosity class III as can be seen from the upper part of Figure 1.

In Figure 1 some observed values are plotted also. Most of the main sequence or nearly main-sequence stars (log g in or close to V area) agree rather nicely with Schmidt-Kaler's relation [V805 Aql and EE Peg (Popper 1981), KM Hya (Andersen and Vaz 1984), RS Cha (Clausen and Nordström 1980), PV Pup (Vaz and Andersen 1984) and V1143 Cyg (Van Hamme and Wilson 1984)].

TY Pyx (Andersen et al. 1981) lies far below the Schmidt-Kaler main-sequence relation, (see section 3). The components of SZ Cen (Grønbech et al. 1977) lie below that relation, too; however, these components are of luminosity class IV at least. Components close to the Straižys and Kurilienė and/or Habets and Heintze relations are YZ Cas (h) (De Landtsheer 1983b and De Landtsheer and Mulder 1983), Vega (Dreiling and Bell 1980), Sirius (Bell and Dreiling 1981), AS Eri (h) (Van Hamme and Wilson 1984) and YZ Cas (c) (De Landtsheer 1983b and De Landtsheer and Mulder 1983). It has to be noticed, that for the hot main-sequence stars, the relations of Straižys and Kurilienė, Schmidt-Kaler and Habets and Heintze agree rather well with each other and with the positions of some well-studied stars/components [Zet Pup (Kudritzki et al. 1983, $M/M_{\odot} = 40$), VV

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Ori (Chambliss 1984, $M/M_\odot$ = 10.2, 4.5), V539 Ara (Andersen 1983, $M/M_\odot$ = 6.25, 5.33), CV Vel (Clausen and Grønbech 1977, $M/M_\odot$ = 6.10, 5.99), Zet Phe (Anderson 1983, $M/M_\odot$ = 3.93, 2.55), χ^2 Hya (Clausen and Nordström 1978, $M/M_\odot$ = 3.61, 2.64), TV Cas (h) (De Landtsheer 1983a, $M/M_\odot$ = 2.8) and RW Tau (h) (Plavec and Dobias 1983, $M/M_\odot$ = 2.55)]. U Cep, according to Plavec (1983), fits better than according to Tomkin (1981).

2. THE EFFECTIVE TEMPERATURES OF THE COMPONENTS OF YZ CAS

At the Utrecht Observatory we have tried to determine T_{eff} of the components of YZ Cas as accurately as possible. Lacy (1981) determined a very accurate mass ratio. Narrow-band lightcurves at 472, 672, 782 and 872 nm provided very accurate radii (De Landtsheer 1983b). As a result we determined log g_h = 3.974 ± 0.003 and log g_c = 4.295 ± 0.003. A low- dispersion long-wavelength IUE spectrum outside phase 0 could be fitted best with a Kurucz (1979) model of T_{eff} = 10300 K, log g = 4 and 10x solar abundance. With a high-dispersion short-wavelength IUE spectrum the overabundance of the metals turned out to be about 10x the solar abundance (De Landtsheer and Mulder 1983).

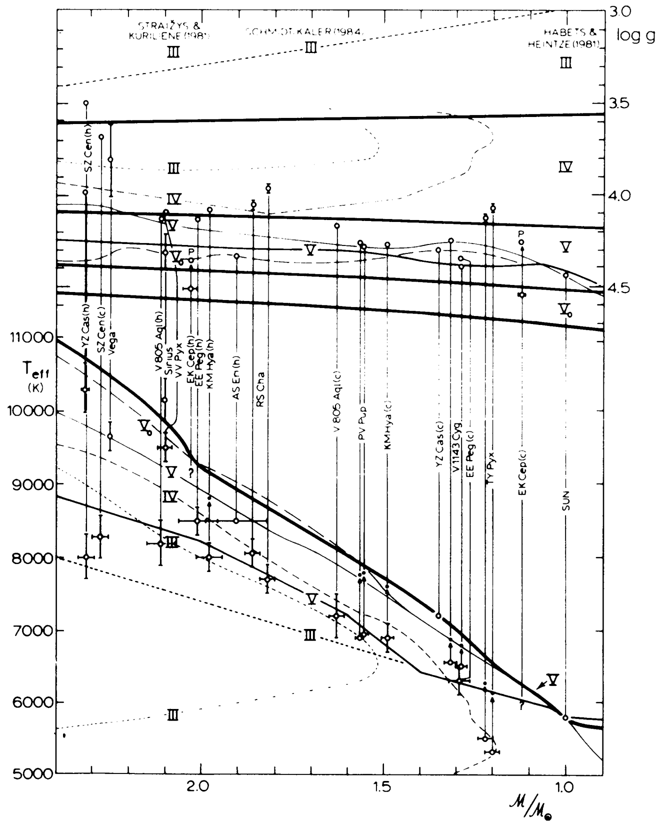

Fig. 1. Theoretical and empirical ($M/M_\odot$, log g) and ($M/M_\odot$, T_{eff}) relations with some recent observational results.

The light curves give for the cool component T_{eff} = 7200 K, in perfect agreement with the Habets and Heintze relation.

In the literature the observed (b-y) index of the primary of YZ Cas varies from 0.008 to 0.020 or even 0.036 (for references see De Landtsheer (1983b)). Eggen (1963) finds (B-V) = 0.005, De Landtsheer and Mulder (1983) find E (B-V) = 0.07. For $(B-V)_o$ = -0.02 the spectral type is B9.5 according to Popper (1980) and A0 according to Schmidt-Kaler (1982). The published spectral types lie between A1 V, A2 IV and A3.7m (see De Landtsheer 1983b for references.).

3. TY PYX

In the (log T_{eff}, log g) diagram, TY Pyx could not be fitted to Hejlesen's evolutionary tracks (Hejlesen 1980) with the correct mass and with (X,Z) = (0.60, 0.02), (0.70, 0.02), (0.70, 0.04) and (0.80, 0.02). Andersen et al. (1981) suggest that the colors of TY Pyx might be reddened by some unknown (presumably circumstellar) mechanism to which the Crawford calibrations do not apply and they propose to withhold final judgement until improved calibrations become available and until the physical phenomena occurring in RS CVn binaries and their causes are better understood.

However, giving the components of TY Pyx the effective temperatures as indicated by the points in Figure 1 (interpolated between the Straižys and Kurilienė relations for luminosity classes IV and V), the positions of these components in the (log T_{eff}, log g) diagram fall on the Hejlesen track with the correct mass and with (X,Z) = (0.70, 0.02). See Figure 2.

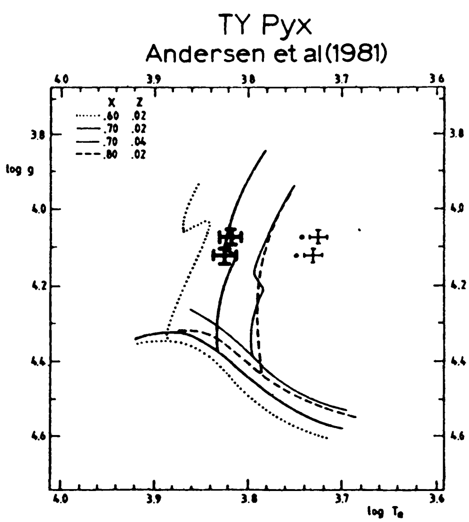

Fig. 2. TY Pyx in the (log T_{eff}, log g) diagram.

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4. CONCLUSIONS

Andersen et al. (1984a) have pointed out that B1 - A1 stars fit (X,Z) $\approx$ (0.70, 0.02), whereas stars of later spectral types fit (X,Z) $\approx$ (0.80, 0.02). With the same procedure as described in section 3 , the positions of PV Pup (Vaz and Anderson 1984) and KM Hya (Andersen and Vaz 1984) can be brought to the Hejlesen tracks with (X,Z) $\approx$ (0.70, 0.02). In the case of YZ Cas (see section 2) an excessive E(B-V) = 0.07 had to be applied whereas the distance is only about 75 pc. A remarkable example of a detached early A-type system, for which Andersen et al. (1984b) found a normal chemical composition, is VV Pyx. The same calibration methods, as used earlier by the Copenhagen group, were applied in this case. See Figure 1.

It would be interesting to find detached systems at high galactic latitudes with masses between 2.2 and 1 solar masses that feature a total eclipse. During the total eclipse energy distributions should be obtained as completely as possible to get reliable temperatures and chemical compositions of the atmospheres. It is hoped that E(B-V) could be found in such cases unambiguously at the same time. In this way the determination of reliable T_{eff} [$M/M_\odot$, log g, abundance] relations should be possible. EK Cep could be a candidate (Tomkin 1983), although its galactic latitude is +12 degrees.

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DISCUSSION

NORDSTRÖM: Concerning TY Pyx and the stars mentioned in paragraph 4 of your poster paper, I would like to make the following comment: To me it seems strange to "correct" the temperatures of specific stars in order to fit the evolutionary tracks of a desired chemical composition when the composition of actual stars is not known to be constant. Moreover, accurate studies show that a given star cannot be expected to have exactly the mean temperature for all stars of the same mass within the main-sequence band, not even for the same log g.

HEINTZE: I am not "correcting" temperatures. I am only saying that I do not believe the published temperatures of some of the stars mentioned in spite of the fact that they were obtained by well calibrated indices. It is quite possible that some still unknown effects influence these indices. As long as two stars with about the same mass (about 2 $M_\odot$) and gravity (about 4.1) differ in T_{eff} as much as 1300 K (about 15%) [V 805 Aql with T_{eff} = 8200 K and VX Pyx with T_{eff} = 9500 K respectively] it is likely that something is wrong. Therefore, for V 805 Aql, just as in the case of TY Pyx, the comparison with theoretical evolutionary tracks is premature.

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